

Preservation of Documents

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सत्यमेव जयते

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of India's Independence.

DEDICATED TO THE MEMORY
OF
MY RESPECTED PARENTS

C O N T E N T S

Title	i
Contents	iii
List of Illustrations	v
Foreword	vii
Preface	viii
Acknowledgements	xii
1. Introduction	1
2. History of paper and other writing materials	4
3. Printing Ink upto 1800	20
4. Effect of sizing materials on paper	26
5. Accumulation of acidity in paper	32
6. Determination of p ⁿ and deacidification	39
7. Repair and Restoration of Manuscripts	55
8. Strengthening of documents	76
9. Disaster control measure	87
10. Salvage of water damaged document	94
11. Non-chemical methods	108
12. Book binding and gold tooling	125
13. Book binding adhesives	134
14. Library building and control of atmosphere	143
15. Deterioration caused by Macro-biological agent and its control	151
16. Deterioration caused by Micro-biological agent and its control	176
17. Pre-constructional ante-termite treatment	185
18. Post-constructional ante-termite treatment	194
19. Microforms in Libraries	199

20. Causes of deterioration and preventive measures of microform	214
Appendix (i) Test of stable papers	228
Appendix (ii) Fibre quality test	233
Appendix (iii) Microscopic Analysis of Fibers	238
Appendix (iv) Specification of Repairing materials	244
Appendix (v) Examination of paper quality before use as preservative materials	252
Appendix (vi) Preservation materials and chemicals	264
Appendix (vii) Availability of preservative materials, equipments and machines	267
Appendix (viii) Selected Bibliography	277
Appendix (ix) Staff pattern of Conservation Division	292
21. Index	293

LIST OF ILLUSTRATIONS

1. Coloured — Get up	
2. pH Meter	40
3. Treatment of Aqueous Deacidification	42
4. Spray Deacidification	45
5. Treatment of Dry Deacidification	48
6. Magnesium Methoxide (Deacidification)	50
7. Kipp's Apparatus	53
8. Tissue Lamination	57
9. Operation of Laminator Machine	59
10. Palmleaf Treated and Untreated	68
11. Vacuum Chamber for Impregnation of Newspaper Blocks	83
12. Freezedryer	85
13. Pheromone Trap	117
14. Folded Box	124
15. Equipments of Bindary	130
16. Gold Tooling	133
17. Termites	153
18. Silver Fish	155
19. Larvae & Pupa of Beetle	156
20. Stegobium Paniceum	157

21. Lasioderm Serricorne (F)	158
22. Thanero Cierus Buqueti Larvae	159
23. Cockroach	161
24. Spray Machines	163
25. Fumigation Chamber	165
26. Vacuum Fumigation Chamber	168
27. Carbon dioxide Fumigation System	174
28. Thymol Chamber	181
29. Treatment of Trench Bottom	188
30. Treatment for Load Bearing Walled Structure	189
31. Treatment for RCC Framed Structure with Columns and Plinth Beams	190
32. Microfilm Camera	203
33. Positive Printer	205
34. Cellulose Structure	242
35. Paper Testing Machine	263

FOREWORD

For a long time, the National Library was looking for a suitable person to author a book on Preservation and Conservation that would cover up-to-date research and findings in the field of Preservation and Conservation in general and of the National Library in particular.

It is really a matter of relief that Shri N. N. Sarkar, Library & Information Officer (formerly Deputy Librarian) who is an expert in the profession of preservation and conservation could be assigned this challenging task. At this rapid progress of preservation and conservation activities at the National Library, I actively associated myself to up-keep the present trend of activity. Besides this, renowned visitors and users of this Library have been pressing modestly to publish a book on preservation and conservation

Being pleased with conservation activities, I requested the author Shri N. N. Sarkar, Library & Information Officer to contribute some work in this field of specialised subject. It is the outcome of his long and continuous association with the preservation work and the valuable experience he gained thereby coupled with his scholastic approach for the subject.

This work presents a large and valuable group of practical conservation and preservation problems of library materials, delineated in a clear and simple language.

It is intended as a comprehensive Manual showing a step-by-step solution to several conservation problems faced in day-to-day practice by the personnel working in the field.

It is our firm conviction that the Book will be found useful by not mere practising Library personnel and Teachers but also by students in the field of Library Science

Dr Ramanuj Bhattacharjee
Director

PREFACE

A library without preservation is analogous to a leaked pot which does not obey the First Law of Dr. S. R. Ranganathan. With the passage of time conservation science developed as a discipline in the wake of its growing necessity in the field of library and archives. Eminent scientists, archivists, librarians, curators and visitors from inside and abroad came to the Laboratory Division of the National Library and approached the author to contribute a document on the preservation of documents. They asked for a guide detailing adoption of the new techniques of preservation in the institution. The author responded accordingly to meet their need by suggesting a method for the repair and restoration of manuscripts and documents.

Now a days Preservation has become a special branch of modern science. It has grown rapidly in the recent past and its branches now extended to almost all the field of preservation of documents.

The purpose of this book is to provide basic theoretical as well as practical information about the preservation of documents. The work is a study of the technicalities and a modest endeavour to present some of the experiments and reasoning through which the information has been gathered and incorporated in this work.

This book will not only serve as a bench reference book for the preservation laboratory but also be a valuable guide to impart training for the technique of preservation of the library personnel. It will also be helpful to the Library Science students.

The work focuses on the causes of deterioration, preventive and curative methods for repair and restoration of documents with the modern techniques adopted in India and abroad. The technology for the Preservation of documents in India is different from that of abroad due to fluctuation of temperature and humidity in high ratios. Deterioration of cellulose is an accelerating process.

The conservation theme of this publication is broadly designed into nineteen chapters and nine appendices. It also contains more than thirty relevant photographs, plates and diagrams to cover all aspects of preservation and conservation.

The first chapter deals with history of paper and other writing materials such as paper, palm leaf, vellum, parchment, stone and copper etc. Manufacturing process of hand made paper and machine made paper is also discussed.

The history of writing ink upto 1800 and effect of sizing materials on paper are elaborately discussed in the 2nd and 3rd chapters. The causes of deterioration of paper have been shown in a flow chart at the end of third chapter.

The paper fabricated after 1860 deteriorates very fast due to internal and external destructive ingredients such as, resin sizing with alum. It contains high percentage of lignin and tannin. Accumulation of acid in paper from air pollution which contains SO_2 , H_2S and NO etc. damages it. Paper becomes brittle for use of acidic dye which is the characteristic of modern writing ink. This is the main point discussed in the fourth chapter.

The Fifth chapter contains the concept of hydrogen ion concentration in the brittle paper and its examination by various equipments. Deacidification of paper is the key point of preservation. Fourteen methods have been discussed for

different grades of brittle and fragile documents.

Convention and modern methods of repair and restoration of manuscripts, palm leaves, vellum parchments, tissue lamination with carboxy methyl cellulose, restoration of colour picture, map and solvent lamination have been highlighted in the sixth and seventh chapter. Reinforcement of document by deacidification and sizing materials is given in detailed methods.

The next two chapters concentrate on various modern methods of salvage of water damaged documents. Rapid preservation processes of fire and flood damaged documents which have been adopted in U.S.A. are also discussed.

The ninth chapter contains some age-old practice and presents preservation processes which are segregated as non-chemicals, such as, neem leaf, encapsulation with polyester, airconditioning system, Polyester folder, Pheromon trap and electrical conductivity box etc.

Next two chapters concentrate on the technique of old brittle book binding and ornamental get up of documents through gold lettering. The use and properties of different types of organic adhesive have been explained on different media.

Chapter thirteenth deals with ideal storage area in the Library building through air conditioning and controlling atmosphere.

Adoptation of non-toxic conventional methods for eradication of subterranean termites which are very dangerous insects as compared to the fire hazard has also been estimated. The use of insecticide has no effect on human body and has no residual effect on paper. The conventional controlling measures of brittle, silver fish, mould, fungi and foxing are highlighted in the fourteenth and fifteenth chapter.

Details disinfection process of documents through modern process, such as vacuum fumigation, thymol treatment etc. and pre and post constructional anti-termite soil treatment of the building are emphasized at the sixteenth and seventeenth chapters to combat virulent attack.

Detailed micrographic system by which newspaper and rare documents is indirectly preserved where physical preservation fails and the cause of deterioration of photographs, microforms, transparence, photo prints and their preventive measure has been discussed in the eighteenth and nineteenth chapters.

Appendices (i) to (ix) contains some essential testing methods of paper for quality control of preservation materials. ISI specification of repairing materials, availability of preservative materials, equipments, machines and a selective bibliography are given for reference. An organisational chart of the Conservation Division along with its staff pattern of the National Library is also furnished.

Dr. Ramanuj Bhattacharjee, former Director of the National Library has been kind enough to write a foreword for this book. For his act of generosity and support the author is indeed very much grateful to him. Dr. O. P. Agarwal, Ex-Director, National Laboratory for Conservation of Cultural Property, Lucknow, Dr. R. P. Malik, Assistant Director, National Archives of India, New Delhi, Mr. Avinashi Lal, Ex-Deputy Librarian, National Library, Mr. S. K. Das, Conservation Officer, Asiatic Society, Calcutta, Dr. Ajoy Kumar Ghosh, Principal Scientist Central Inland Capture Fisheries Research Institute, M.S.O Building, 'DF' Block, Salt Lake, Cal-64 have taken trouble to review the manuscript. The author expresses thanks to them.

The Author has discussed the contents of this work with his senior colleagues. However, the interpretation as also the errors and discrepancies, if any, are the author's own for indulgence to the readers.

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PRESERVATION OF DOCUMENTS

INTRODUCTION

In a large library, different varieties of cellulosic materials are housed which are easily decomposable and vulnerable to deterioration. The deterioration of cellulose matters obeys the law of thermodynamics which states the rate of reaction on the paper is directly proportional with temperature and inversely proportional to humidity. The paper manuscript, palm leaf, map, painting on paper or cloth, parchment, vellum, are all cellulosic materials and prone to decay very fast thus becoming unfit for use, if proper care and handling is not done. The various other factors (external & internal) also damage such material if not maintained properly. These agents can conveniently be grouped into four categories such as physical, chemical, biological agents and accidental agents.

The deterioration is more in libraries of tropical countries due to the hazardous climates and excessive ravages of insects. These materials can last longer period if properly maintained. With a view to making out the process of Preservation it is necessary to consider why and how does the library materials deteriorate, what are the various factors of deterioration, when this concept is clear then only remedial action (curative method) can be taken.

The Preservation technique has drawn the attention of the scientist, restorer, chemist globally to preserve the library and archival materials. Preservation is the process of treatment which makes an object to last longer. Preservation of documents constitutes of two aspects (i) Preventive method i.e. conservation (ii) curative method i.e. restoration.

PRESERVATION OF DOCUMENTS

Preventive Method (Conservation)

Preventive measure is an assistance to create a healthy environment in which the decay or deteriorating agent of the Library cannot exit.

The factors that constitute preventive methods include :— temperature, humidity, control of acid deterioration in paper, insect, fungi and control of light, proper house keeping and maintenance, removal of harmful gases, acidic chemicals, dust, fire cases, in handling flood etc.

Curative Method (Restoration)

It is surgical operation comprising of the elimination of the damaged material and there replacement by best material for reconstitution of the original format.

The factors that constitute curative method involves : Deacidification prior to restoration.

Restoration by either conventional or by modern process. Many new techniques and methods have been explored to give fresh base to the decayed materials. It is, however, worth mentioning that these techniques include two types of activities.

Preventive and curative

Preventive methods tend to reduce the rate of decay of Library materials and thus they are more general so as to suit the different types of library materials. The curative methods are material oriented and, therefore, they have variations according to state of the physical condition, quality and nature of the material to be preserved. This will thus be clear that in adopting curative methods, it is of paramount importance to

PRESERVATION OF DOCUMENTS

understand the nature of the material to be treated and the technique to be adopted to bring it to original state.

PRESERVATION OF DOCUMENTS

HISTORY OF PAPER AND OTHER WRITING MATERIALS

Writing materials commonly used before the invention of paper were many and varied. Probably the first was stone in which the ancient Egyptians carved their character with chisel. Later came to the use of bricks by the chaldeans. Their method was to impress the characters with some form of stamp or stylus into tablets of soft clay which could then be hard by firing to give the writing permanance. Later steel metals such as lead, copper, brass and bronze were used as writing materials, the letters being cut into a sharp pointed instrument. By the time of the Greeks and Romans, one of the commonest forms of writing was by means of the stylus, a sort of pointed metal pencil upon wax-covered wooden tablets. These tablets could be used continuously, as it was only necessary to melt the wax to provide a fresh writing surface. Tree bark has at various times been used as a writing materials, while in India and Ceylon palm and other leaves have been used in recent times. Prior to the invention of paper, the most important writing materials were papyrus, parchment and Vellum.

Papyrus

Papyrus was introduced as a writing material by the Egyptians in about 3500 B.C. and was regularly used until the introduction of Parchment. It was prepared by cutting the stem of the papyrus plant into two feet length and splitting them downwards into water, thin strips with a needle or sharp knife several strips were then laid side by side on a board and coated with a paste made from a mixture of flour and Nile mud. Across these, other strips were laid at right angles. The sheet thus assembled was either hammered or put into a press, after which it was dried in the Sun and polished with a

PRESERVATION OF DOCUMENTS

bonetool so that its surface could be written upon in ink with a soft quill. Books were made in long rolls prepared by pasting several such sheets to get her to form a continuous length. To this a wooden stick was attached at each end so that the book could be rolled or transport and storage.

Parchment

Parchment is the most beautiful and suitable writing material prepared from the inner side of the split skin of a sheep. It was probably used as early as 1500 B.C. though there is a legend that it was invented in the 2nd century B.C. by Eumenes. II, King of Pergaman an ancient city of Asia Minor. Eumenes prepared his entire library on parchment made from the skins of sheep, goats and pigs. This parchment became known as charta pergamena.

Vellum

Parchment was equivalent in older language to vellum but in strict sense there is a difference. Both are animal skins, but they are neither equal in quality nor in texture, nor in the methods of their preparation. Vellum is a writing material made from the skin of a new born calf. It had also a finer, whiter and smoother surface than parchment and hence in those days it was used only for costly manuscripts.

Vellum is first washed and cleaned by a long exposure in lime. Secondly it is stretched in the Sun and dried. Third treatment is trimming with a knife. Fourth one is dusted with chalk and rubbed smooth with pumice stone. This treated piece of vellum can be written or printed upon or can be dyed or stained for book-binding purpose.

Parchment and vellum books appeared in the 3rd century A.D. Instead of being continuous rolls, sheets of parchment or

PRESERVATION OF DOCUMENTS

vellum were folded down the middle to make a unit of two leaves of four pages. The successive sheets were then laid one on the top of the other and stitched together at the fold in such a way that whenever the book was opened, the two opposite pages were found to be of the same texture, both being either the 'flesh' side or the 'hair side'. The book thus secured was then bound together between two wooden boards which were sometimes ornamented and sometimes covered with leather.

Early Writing materials of India

Writing materials commonly used in ancient India were of two kinds (i) some were durable and more or less permanent while (ii) others were perishable in nature. To the first group belonged such materials as stone, copper, iron, gold and silver while the second belonged such soft and perishable materials as birch bark, palm leave, cotton and silk cloth etc. The former were used for recording royal edicts or proclamations, royal eulogy and legal documents while the latter for books and ordinary correspondence.

Durable materials, Stone or Rock

When the art of writing became more or less common only such documents as were desired to be permanent were engraved or incised on rocks, pillars of stone and the walls of caves and temples. Such 'Sermons in Stone' and other monumental writings are found scattered all over the country. Most of them are the inscriptions of the great Buddhist emperor Asoka belonging to the 3rd century B.C. and they are the first indisputably datable specimens of writing of India. Rough stone was used for writing purposes, the ground was often prepared by rubbing and polishing before writing was incised. To lend beauty and grace to these inscriptions margins were

PRESERVATION OF DOCUMENTS

often left on all sides and sometimes the surface of writing was lowered than the rims on four sides. With suspicious religions symbols engraved at the top and bottom of the inscription. Complete literary works were also written sometimes on stone. One rock Ashokan edict is still in the Asiatic Society, Calcutta.

Clay tablets or Bricks

Though clay tablets or Bricks did not constitute the commonest form of writing materials in India as they did in ancient Babylonia and Mesopotamia, they were used from time to time for writing purposes of a few specimens which contains 'a single letters originally set up on the walls or niches of temples or pedestable of images were discovered by Cunningham and other Archaeologists in different parts of India. Religion Texts were also inscribed sometimes on such clay tablets, a specimen of which containing Buddhist's sutras were discovered by Hoe in the former North West province. Besides clay tablets or bricks, earthenpots and seals were also used as writing materials.

Wooden Boards

Wooden boards as the media of writing had been in use in India since the Buddhist age. We find reference to it both in the Vinayapitaka and the Jatakas. These writing boards were then known as phalakas which were used by the beginners for learning the alphabets. From the Buddhist work 'Lalitavistara' we come to learn that boards made of sandal wood were used like slates in schools. Pieces of varnished wood were also used at times for writing love-letters the reference to which is found in the Dashakumara-charit, a sanskrit fiction by Dandi. Wooden boards were also used for writing manuscripts. The Bodlein library at oxford possesses on Indian manuscripts

PRESERVATION OF DOCUMENTS

written on such wooden boards.

Metals

Out of the metals in common use the most prominent were gold, silver, copper, brass, bronze, iron etc. Since the gold is a precious metal, it was used for important documents. Silver though cheaper than gold was still in use as writing material.

Copper was most widely used as writing material since very ancient time down to almost the 12th century A.D. The copper plates were hammered into various shapes and sizes such as of palm leaf and brick-bark. The inscribed copper plates were called by different names viz. tamrapatra, tamrasasana, danpatra etc. according to the contents of the inscriptions.

Statues were made of brass. The bells in the temples were made of bronze and those bells were some times inscribed with the names of donar and the date of donation.

Iron was hardly used as a writing material probably because it was subject to rusting and decay.

Perishable Materials : Birch-bark

Birch-bark better known as "Bhurjapatra" was the most popular of early Indian writing materials. It was nothing but the inner bark of the tree called Bhurja that grow plenty in the Himalayan regions. Birch-bark were cut into pieces of different dimensions, generally one yard long and as broad as the writer required and liked. In order to make their writing surface hard and smooth they were rubbed with oil and polished. These leaves were then held together with a string through their middle portions which were usually left unwritten. The compact book was then fastened to two wooden boards which not only protected leaves but also

PRESERVATION OF DOCUMENTS

served as its get up.

Birch-bark was used not only for writing books and long documents but also for conducting correspondence including love letters, the reference to which is found in the 1st canto of "Kumarsambhaba" by Kalidas where it is written that the celestial damsels used to write.

The earliest specimen of writing on birch-bark is the famous Dharampada written in Kharosthi script which probably belongs to the 2nd or 3rd century A.D. It was discovered in Khotan. Others of this category are the famous Bower and Godfrey collection and those of Bakshali Arithmetic which belongs to the 6th and 8th in different libraries in India and abroad.

Palm-leave or Tala-patra

As a writing material palm-leaf or talapatra was very popular in ancient India probably because it was easily available in quantity in almost every part of the country except in Kashmir and some parts of the Panjab and Rajputana. Still it seems that the use of palm-leaf as writing material was probably initiated by the people in the southern most parts of the country where it was chiefly available in plenty and gradually its use spread to other parts. One of the most ancient Buddhist works the Tripitakas written shortly after Buddha's death it is said, was written on palm-leaves. Such ancient palm-leaf manuscripts have not, however, survived chiefly due to the Indian climate. The datable manuscripts on palm-leaves known are possibly a few fragments in the Godfrey collections and the Hrozny MSS which belongs to the 6th century A.D. Palm-leaf had, however, to be prepared by first soaking it in water and then by drying it in the Sun. It was sometimes three and half feet long and three inches broad at the middle. It is used even now in the country by the beginners in the

PRESERVATION OF DOCUMENTS

primary schools for writing alphabets.

Cotton, Silk cloth and Skin

Cotton and silk cloth had also been used in India for writing purposes since ancient times. It was then called 'pata' or patika. A silk band containing a list of Jain sutras written with ink was discovered by Buhler at Jasalmer and manuscript of the Jain work 'Dharmavedhi' written on cloth dated 1361-62 A.D. was found by Peterson at Anhilavad patan. But manuscripts written on cloth or silk cloth prior to this period have not survived mainly because such materials could neither stand the onslaught of weather nor the onslaught of moths and worms.

There is reference in some Buddhist works as also in a Sanskrit work 'Vasavadatta' by Subandhu that skin was sometimes used as a writing material in those days.

Short History of paper

History of paper is an exciting story to tell and is rather old, though not as old as that of other writing materials. Nevertheless paper is of a great antiquity. Its very name has a distinctive Egyptian flavour. The term 'papyrus' from Greek papyrus of Egyptian origin and various theories have been suggested with regard to its original meaning. It has been seen that papyrus was not genuine paper. The real paper came into use only in the early part of the 2nd century A.D. and tradition says that it was invented in China. It is said that in about 105 A.D. the invention of paper was first officially reported to the Chinese emperor by a courtier named Tsi-lung. He is therefore regarded as the father of the invention of paper in Chinese history. The Chinese kept the secret to themselves quite a long period of time. But the secret somehow leaked out from Korea, then a Chinese province. It is said that

PRESERVATION OF DOCUMENTS

a Buddhist monk who carried the secret with him from Korea introduced it into Japan in 561 A.D. and was handsomely rewarded for it.

He later on rose to be the physician to the Japanese empress. But while paper was made of rags in China, it was manufactured from the bark of mulberry trees in Japan.

The next country to acquire the secret was Turkestan. In 751 A.D. a battle took place between the Chinese and the Turks which resulted in the defeat of the former and the capture at the hand of the Moors of quite a large number of prisoners among whom there were several paper-makers. These paper-makers were forced into work and with their help the first paper mill was set up at Samarkand in 751 A.D. and another at Baghdad in 793 A.D. Here paper was, however, made of linen-rag and was therefore, both fine and lasting. The Moors guarded the secret and practically enjoyed the monopoly of paper-making till the middle of the 12th century. It was with the growth of Muslim power and civilisation that paper started moving to the west by crossing the Mediterranean and the first country in Europe to welcome it was Spain, where the first paper mill was established at Toledo in 1150 A.D. Paper then travelled to Italy and in 1276 a mill was established at Fabriano. Oriental paper did not bear water-mark so long. It was in Italy that the water-mark and glue sizing processes were invented which were introduced into oriental paper nearly two or three centuries later.

Raw materials and dating of paper

The principal raw materials of which paper is generally manufactured are cotton, linen rags, esparto, straw hemp, bamboo and wood. Cotton rags yield by far, the pure cellulose, the finest grades of paper are made from them.

PRESERVATION OF DOCUMENTS

Their fibres are nearly an inch long on the average very fine and strong. They are really the most durable of all papers.

Linen, rags yield also pure, high quality cellulose. Their fibres are as long as cotton fibres but thicker than them. But as linen is very scarce, it is often mixed with cotton for making ledger papers and thin bank papers, and is hardly used as the sole material of paper making.

Rag was the only material in regular use for book and writing papers up to 1861. Linen and cotton are the only two rag fibres of any importance and although the various authorities seem to agree that the former was used first in Europe, there is difference of opinion as to the date at which cotton first appeared. Some labels bearing written characters and dated 1342 are thought to be the earliest linen papers in England, and some wills in the office of the Bishop of Norwich dated 1370 are certainly composed mainly of linen. Briquet, however examined 122 papers prior to the fourteenth century the oldest being authentically dated between, 960 and 1249. He found that linen only was present in papers of the tenth eleventh centuries, and that only traces of cotton occurred in papers of the twelfth and thirteenth centuries. This is contrary to many opinions on the subject.

Straw

The first experimental book made of straw paper was published in 1800. In 1860 straw was being used regularly in admixture with rags. Straw was formerly used only for making cardboards, wrappings and low quality paper because its fibres are short and brittle, paper made from it is not lasting.

Esparto or alfa grass is a strong bladed grass that grows in north Africa and Southern Spain. As it has very short fibres

PRESERVATION OF DOCUMENTS

whose average length does not exceed 1.5 mm paper made from neither strong nor durable nor can it retain its colour for long. It has, however, as fine, smooth and clean surface and can be suitably used for writing and printing.

Hemp, Bamboo, Sabai and others.

Paper made from hemp is thin but opaque and very expensive. It is sometimes used in printing the Bibles and the prayer Books. Bamboo is largely used in India for manufacturing paper first small scale plant is set up in 1919 and large scale production was started in the year 1930, in India. But as its fibres are short and brittle no good paper can be made from it. But manilla which has fibres long and strong can produce really tough papers.

Mechanical Wood pulp.

The next source of paper-making material is wood, which has 55% cellulose content and is now the chief raw material of paper-making throughout the world. It is used in the manufacture of low grade paper. The best fibres are obtained from such trees as spruce, pine and fir, but shorter and weaker fibres are obtained from such trees as popular and others. Prior to paper-making the selected wood is reduced to pulp. This pulp is of two kinds. The first is known as mechanical wood pulp. In this, wood is grinded into water and saw-dust instead of being chemically disintegrated and as a result it retains all the impurities i.e. the inter cellular matter. Hence paper made from mechanical wood lacks strength and turns brown and brittle under long exposure to light. The enormous consumption of paper in the world today has brought mechanical wood into use on a wide scale, specially for newspapers and the paper so used is known as newsprint in the trade.

PRESERVATION OF DOCUMENTS

Chemical wood pulp

The wood is first cut into pieces, usually about an inch square. These pieces are then reduced to pulp by boiling them in water with soda or sulphite which removes impurities such as lignin, pectin, tanin, vegetable colouring material but keeps the length and strength of the fibres intact. Paper made from this has greater strength and does not fade so easily.

Processing of Raw materials

Raw materials are at first reduced to cellulose pulp form which paper is made. As soon as these materials arrive at a paper mill buttons, pasteners and robbers are all removed and they are cut into small pieces over a sieve. In order to remove dirt and grit they are then air-dusted. The chopped pieces or rags are then boiled in water under pressure for several hours and alkalis such as caustic soda, soda ash or lime are added in order to wash away the colouring and inter cellular matter. The rags then go into a machine called "breaker" or "hollander" in which they are washed in water and reduced to pulp. The breaker consists of a tank and a revolving drum, the former being fitted with the latter. One drum can, however, be raised or lowered according to necessity.

Now there are two opposing series of blunt knives. One fixed on the surface of the drum and the other on the bed of the tank and as the drum revolves, the rag materials pass between the two sets of knives and are further broken up and frayed and simultaneously washed by a clean flow of water in the machine. At this stage, the materials are reduced to pulp called "half stuff".

The half stuff is then passed into another machine called

PRESERVATION OF DOCUMENTS

"beater" which resembles the "breaker" in every part of its construction. If the knives are sharp, the half stuff is beaten quickly and broken up into fibres of short length and as a result a weak, fluffy and absorbent paper known as antique or feather weight or blotting paper is produced. On the other hand, tackles are blunt, the half-stuff is beaten slowly and consequently such hard papers as blank papers, Ledger paper etc. are produced. The pulp at this stage is known as "Stuff" the working material of the paper maker. The beating process being over colouring matter, China clay or size may now be added in the "beater" according to the quality of paper to be made. If paper is sized in the beater it is known as "engine sized". If, however, the finished sheet of paper is dipped in a tough of gelatine and slum, it is known as tub-sized. Blotting paper is neither loaded nor sized. Now the paper is defined as a material composed of vegetable fibres freely inter twisted with each other so as to form a sheet upon which it is possible to write.

This naturally differs from Parchment and vellum which are nothing but animal skins. Papyrus is nearly strips of a river plant which is not disintegrated but dressed, dried in two and Polished.

The Technique of Paper making by hand

From its invention in 105 A.D. to the year 1798 when machine process was invented by one Nicholas Louis Robert all paper was made by hand. Though most papers are now machine-made, hand making is still continued in certain mills producing finest grades of paper. National Library using hand-made paper for mending the books. Hand made paper demands greater care and more practice which machine-process does not require. The stuff from which paper is made and then stored in vats. For hand-making the stuff should

PRESERVATION OF DOCUMENTS

have a thicker consistency looking more or less like bread sauce while for machine-made paper the stuff should be comparatively thinner, looking more or less like grue. The vatman then dips his mould into the vat.

It has already been described, the stuff from which paper is made is prepared from rag material, esparto, wood or other substances, and is stored for use in vats. It is converted into paper by the use of a mould. This is a shallow sieve, set in wooden rectangular frame than broad, and can be one of two types, either laid or wove. A laid mould is one whose base is formed of a close series of fine wires (laid wires) lengthwise, and crossed at roughly one-inch interval by thicker wires known as chain wires. If a piece of paper formed in a laid mould is held up to the light, the pattern of these crossing wires can be clearly seen, being more transparent than the rest of the paper. (N.B. it should perhaps be noted here that it is possible to imitate this pattern in machine-made paper by means of the "dandy roll"). A wove mould is one in which the wires forming the base have been loosely woven on a loom in a manner similar to cloth. Paper made in such a mould has a smoother and more even surface and reveals a faint fabric-like pattern when held upto the light. Credit for the invention of the metal-based wove mould is usually given to John Baskerville, who first used wove paper in his edition of virgil printed in 1757. Both laid and wove moulds are usually fitted with an outer frame or deckle. Its object is to hold the pulp in as also to determine the size of the resultant sheet. The deckle-edge is nothing but the rough and wavy edge which uncut books possess. This happened due to the overlapping of the liquid pulp against the sides of the deckle. In paper we often see a design in transparent lines which goes by the name of water-mark. This is made in paper by twisting or soldering the wires of the mould in the form of a design or a

PRESERVATION OF DOCUMENTS

pattern. It is partially useful in determining format, in dating an undated work.

The operator who handles the mould is called a Vatman. To form the papers sheet he dips the empty mould into the vat and fills it with stuff. He then lifts it up and applies a peculiar shaking movement, backwards and forwards and from side to side almost simultaneously. This causes the individual fibres in the stuff to interlock in all directions, and given great strength to the sheet of paper which is thus formed in the mould as the water drains away through the base wires. The mould is now passed to the coucher who turns it over and deposits the newly made sheet of paper on to a felt, immediately covering it with a second felt. On this another sheet of paper is laid and covered, and thus a paste of sheets and felts is built up. The paste is now put under pressure and as much water as possible is squeezed out. Next comes the work of the layer who strips the sheets from the felts and piles them into packs. This calls for considerable skill, for the paper is still wet and liable to tear. The packs are next pressed for several hours, after which the individual sheets are stripped off and hung in a loft to be air dried. After these processes the sheets of paper, though formed and dried, are still absorbent, rather like blotting paper and are known as waterleaf. They are next sized with gelatin, which gives them a non-absorbent surface, so that they can be written or printed upon. This is done in a tub through which two endless bands of felt travel slowly with the water leaf sheet between them. The paper then passes between rolls which force the size into it after, which it is first dried between hot felts and then hung in the drying loft. Finally it is smoothed, pressed, and glazed if necessary.

Machine made Paper

The manufacture of paper by machine does not require as much skill and care as paper making by hand does. Nevertheless it can produce a fairly durable material. The machine by which paper was first manufactured is called the Fourdrinier (which first patented in 1798 by one Nicholas, an employee in the French Publishing House owned by Francois Didot but it was first practised in England). This machine consists of two parts. The first part of the machine contains a "stuff chest" a feed box strainers or squeezers and an apron cloth. The second part of the machine consists of an endless moving band of wire mesh. The method of manufacture is as follows.

The stuff is run in the stuff-chest which can store nearly half a ton at a time from which it passes to the 'fed bod' in which it is reduced to a liquid state by mixing it with water. This material then passes under strainers or squeezers to be free from grit and knotted fibres and then under an apron cloth which carries it to the second part of the machine i.e. the band of wire-cloth. As the wet stuff moves along the endless band of fine wiremesh, the fibres interlock and as a result water drains through the wire cloth. There are, however, two endless rubber deckle straps on both sides of the band of wire mesh which move along with it. Their purpose is to prevent the pulp from running off the sides of the band of wire mesh. While the pulp travels along the band of wire mesh, it is however, mechanically shaken from side to side in imitation of the vatman's hand. This causes the fibres to interlock only in one direction and as a result machine-made paper is strong only one way. The newly formed web of paper still wet then passes under a "dandy roll" a hollow cylinder upon which a device in the form of a water mark is worked in

PRESERVATION OF DOCUMENTS

relief. This device was patented in 1825 by John and Christopher phipps. As the web of paper passes under the dandy roll, the design or the watermark is impressed upon it. If necessary chain lines and wire lines and even woven effect of hand made paper can be artificially produced on machine-made paper by this method.

The paper thus made passed further through three press roller and then again it travels along an endless band of felt, a closely matted fabric of wool made by pressure of drying cylinders to be fully dry. It is then wound up on a reel into rolls.

The Printing ink has been used from the inception of writing material. It is one of the important deterioration factor on paper and is discussed in the next chapter.

PRESERVATION OF DOCUMENTS

PRINTING INKS UPTO 1800

Ink has been the basic material of writing. Those who were engaged in ink making in earliest time whether for their own use or for others, were not anxious to disclose their secrets. The ink-maker was closely associated with the craft of printing, either as a part of it or as a supplier. The printers were noted for their carefulness in preserving to their own exclusive use for the fruits of their experience.

Although one of the essential materials of printing together with type and paper is ink, but the printers regarded it least worthy and least important. Looking back into the efforts of early printing, it was seen traces in China. Earliest Chinese printing was carried out in 251 A.D. from wooden blocks, block of clay or metal, on which characters were carved out by hand. The ink used for printing from those blocks was identical to the writing ink of that time i.e. a thin water base fluid. This ink consisted of lamp black with gum in paste form. It was placed in moulds to dry and was sold in sticks. It was ideal for block printing from wood cuts.

The first Chinese alphabets with its vast number of characters would have made the creation of a type foundry, a formidable undertaking and the liquid Chinese ink, based on water reticulated on metal type and did not spread evenly but stayed in globules and thus resulting in unsatisfactory print.

The Strassburg's Manuscript of late fourteenth century describes the making of oil varnish, in which other ingredient copper was used as a drier and the varnish was bleached in Sun. From this, it is clear that the importance of the use of drying oils in varnishes was known, well before the need for quick drying printing ink arose.

PRESERVATION OF DOCUMENTS

Pliny observed that oil paints were known to the Romans which have been used for decorating the shields etc. Flemish painter, Jan Van Eyck (d. 1441) perfected the oil paints and popularized them. Gutenberg (1400-68) utilized this knowledge along with Fust and Schoeffer. Gutenberg if not an inventor is credited in adopting the then existing materials and formulations for printing ink. In the works of Gutenberg, Fust and Schoeffer the eye is immediately struck by the blackness of the ink without the unpleasant haloes. The first even published book (1456) is Gutenberg's 42 line bible, which has super quality of printed matter.

Gutenberg used the best material, and therefore, old nut oil with little yellowing property would have been chosen for varnish. This would have been cooked to give it the drying properties. Carbonization of the oil would have been done by the addition of some organic materials. The varnish would have been strained and mixed with pigment i.e. lamp black.

One page of the 42 line Bible is red in colour. The problem with dark black ink is rather simpler than the red ink used in the 42 line Bible of Mainz, because it required more clarity in oil. Vermillion was used as pigment for the red colour.

No early formulation of the early printing inks is available but the purchase book of Ripoli Press of Italy for the year 1481, gives a long list of different materials viz linseed oil, turpentine oil, vermilion, black pitch, vitrol, lake, hard varnish liquid varnish etc.

British Museum Sloane manuscript proved a few recipes of late fifteenth century. In one case, it describes the use of Oleoresinous varnishes, prepared by heating oils of nut or linseed and adding Frank fort black (Lamp black) as pigment.

PRESERVATION OF DOCUMENTS

Copper and red lead were used as driers. This varnish was used for printing on cloth.

In France Plantin (1567) gives the first direct evidence of the manufacturer of typographic ink by using turpentine oil and lamp black — Cannerparius in Venice during 1817 prepared printing ink by heating linseed oil and gum sandrac together. In Paris, in the 1645, Abraham Bosse prepared varnish for copper plate which was very close to typographic varnish. He used purest meat oil and burnt it for half an hour in case of thin varnish and for longer time in case of thick varnish was needed. Then the varnish was cooled. He also recommended the use of onion or bread crust to make the ink less greasy.

In 1683, Moxon gives a dutch method for making ink varnishes. In this method, good old linseed oil was heated and an onion was dipped to judge its temperatise. The rate at which the forth formed after the onion was dipped is important. Ground rouin powder in the ratio of $\frac{1}{2}$ lb to 1 lb per gallon of oil was added to the heated oil. Slowly to prevent forthing the oil which was then ignited to make the varnish harder. One ounce of litharage was added to each gallon oil. After cooling, it was strained and allowed to stand.

During the eighteenth century, a large number of formulated printing inks and varnishes were found in France, England and Germany. Fertet, in 1723, described the use of linseed oil or walnut oil. The oil was boiled for two hours and a crust of bread was thrown to decrease the oil. The oil was further simmured over low flame for 3 hours, & tested for threading self ignition of oil was avoided. If the printers desired to improve drying qualities they used to add aged turpentine oil which also prevented halation. Lamp black was added to the cooled varnish until proper consistency is reached. Walnut has got more saturated acids and acetic acid which makes it

PRESERVATION OF DOCUMENTS

slower drying as composed to linseed oil, but it has got the additional advantage not yellowing and is important from the point of halation. The use of sandrac and turpentine have the effect of increasing the viscosity of the varnish.

Eertel's receipts remained in use with inner changes during the subsequent year. In 1740, Muller suggests the addition of copiba balsam which was quick drying expensive. He also suggested the use of asphaltum and litharge for quick drying. In 1760 Borkeville prepared fine quality of ink varnish by adding small quantity of resin and amber and then allowing it to stand for a few months to attain maturity before adding carbon black pigment. Papillon in 1766 modified the Fetals method of ink making by adding a little soap to the varnish, which enabled quick transfer of ink from metal to paper and also made it easier to work.

Monoro in 1793, Micholson in 1795 and Quinquet in 1799, used linseed oil or nut oil for preparing typographic varnish & opined about the quality of their ink, although it depended on the type of oil and its quality they used. Onion or bread crust were always used by them for retaining the grease.

In India, the printing started in 1555 in Goa by mission, the printers prepared their own ink-varnishes or they imported it from the European counterparts. Printing ink technology was much in infancy in India upto 1800 due to very limited printing activities. The ink varnish was manufactured from linseed oil and the pigment was lamp black.

Effects of Bud Mills

Incunablas set a standard in printing. But later, books were not found as good. The reason for this had been bad inks. Early printers used to take extreme care in their process of ink making and in selection of materials, but the competition

PRESERVATION OF DOCUMENTS

in later stages and the growing demand of public needed quick & cheap results and therefore the quality gradually declined.

Making of lampblack and varnishes were the time consuming and troublesome procedures. Lack of care could result in inferior product. Proper heat treatment of linseed oil or nut oil was of great importance, which took a few hours, and if not done to the desired degree the ink would not have the bodying effect. Such ink when used would spread into the paper leaving the black behind, causing brownish less sharpening of the print.

Cause and effect of Bud ink

New oils always have mucilagenon products with them floating as importants. An ink warmists from such an oil is darker in colour and not very good. Greasy material of the oil cause halation. Onion or bread crest when burnt in the oil remove grease. It is supposed that the carbon of these materials absorbed the fatty acids and removed the grease.

Grinding of ink if not properly attended could leave undispersed lumps, which could cling to the side and etiolated the small latter.

Moxon had noted that Englishmen were using resin in larger quantity because it was cheap and easier to prepare. Rosin, if not used moderately caused the ink to dry too quickly and layer the paper and also the ink tend to turn yellowish.

The black (soot etc.) if not calcined to get rid of the tomy material, would also earn stainy.

It is clear that the many constituents of bud ink have their real origin in the desire on the part of the printer to reduce

PRESERVATION OF DOCUMENTS

its cost whether it be in time taken or the actual cost of material. It is interesting to note that there has been a general improvement in the nature of the ink from late eighteenth century.

PRESERVATION OF DOCUMENTS

EFFECT OF SIZING MATERIALS ON PAPER

Sizing material is used to resist the penetration of liquid on paper, such as water or writing inks. End of eighteenth century, machine made paper manufactured and rosin sizing used internally. The rosin sized with alum consists Aluminum, Iron which acts as catalytic reaction with SO_2 & H_2S etc. on paper. The air pollution contains SO_2 & H_2S come in contact with the paper where SO_2 oxidises to SO_3 and further oxidation, it becomes H_2SO_4 which breaks down the cellulosic structure. The restorator will help to preserve the brittle and fragile documents. The sizing is one of the constituents which governs the mechanism of the paper. It is used on internal and external of the paper and precipitation of rosin sizing with alum.

The two principal sizing processes are internal sizing and surface sizing. Internal sizing consists of mazing the sizing agent with the fibrous furnish and forming the entire mass into a sheet containing a relatively uniform distribution of fibers and sizing agent.

Surface sizing on the other hand involves the application of sizing agent to the surface of the already formed paper. Surface sizing is usually done in a size tub, size press or on the calenders surface-sized papers, which generally contain internal size.

Internal sizing

The amount of rosin size used in the sizing of paper depends upon the functional requirements of the paper and the efficiency obtained from the size. The amount varies from 0% size in absorbent papers to about 5% size in certain speciality papers and paper boards.

PRESERVATION OF DOCUMENTS

The sizing value does not increase in direct proportion to the amount of sizing agent added, even in the commercial range. The greatest increase per increment of added size is generally obtained in a range of about 0.75 to 1.5% size on the weight of the pulp. The efficiency then decreases with higher percentages of size up to about 2 to 3% size, depending upon the type of pulp and mill conditions, after which further addition of size results in greatly reduced efficiency. In these grades extra size is needed to obtain the results desired even though the efficiency of this extra size is rather low. Since ink resistance normally increases with increasing rosin size long after the water resistance test has begun to show very little further improvement.

Precipitation of Rosin Size with Alum

In order to obtain the desired results from rosin size, it must be precipitated in the papermaking stock with alum. Unless alum is added, the rosin size will be washed out of the sheet.

Acids, acid salts, or the salts of alkaline earth metals can be used in place of alum for precipitation rosin size, but the sizing is not so good nor so permanent as that obtained with alum. In rating different precipitating agents, Simionescu reports decreasing effectiveness in the order of alum salts, chromium, iron, Manganese, and Nickel.

Because of its almost universal use as the precipitating agents for rosin size, alum is of very great importance in sizing. The formula for papermaking alum (which is not a true alum at all it is not a double salt) is generally represented as $\text{Al}_2(\text{SO}_4)_3$, commercial alum, however, contains an excess of Al_2O_3 over the theoretical formula and is slightly basic. It also contains approximately 145 molecules of water of crystallization.

PRESERVATION OF DOCUMENTS

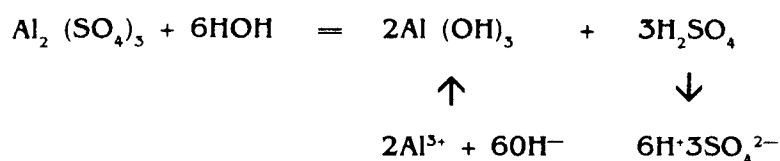
Alum is made from bauxite ore (a naturally occurring hydroxide of aluminium) by pulverizing the ore and reacting with sulfuric acid in lead-lined tanks. This forms aluminium sulfate which is decanted or filtered from the sludge (silica and other materials) and the solution boiled down and allowed to harden. The final product is sold in granulated powdered, or liquid form. Alum can be made in the paper mill (kaning process) by reacting sulfuric acid with clay, but this process has the disadvantage that part of the iron-soluble residues are left in the alum and added to the pulp. Most commercial alum used in paper making is purchased from a chemical company in granulated form. Alum is nonhygroscopic. There are several grades of low-quality alum, in particular slab alum (not over 16% Al_2O_3) and crude alum (obtained by dissolving bauxite in sulfuric acid) but these are not used much any more for liquid alum has been growing in use in recent years because of its lower cost and ease of handling. It is supplied in tank cars or tank trucks. Liquid alum is equivalent to the solution obtained before boiling down. A typical liquid alum contains about 47% dry alum or about 8% Al_2O_3 .

The iron content (expressed Fe_2O_3) of alum must be below about 1% for newsprints and about 0.3% for writing and book papers and the iron must be essentially all in the ferrous state. These requirements are ordinarily met by regular commercial papermaker alum, but for special papers where permanence is important, hydrogenated rosin and in case of photographic papers, stearic acid is generally used. Alum is generally dissolved in water before adding to the paper making stock containing the rosin sizing. It dissolves easily and has a very low heat of solution. Generally warm water is used, although alum dissolves fairly well in cold water. Solutions of 10 to 22% solids are stable indefinitely. Metering systems and feeding devices for continuous addition are

PRESERVATION OF DOCUMENTS

frequently used, and should be made of type 316 stainless steel. Sometimes alum is added by dry addition directly to the beater.

When dissolved in water, alum hydroxide converts as follows.



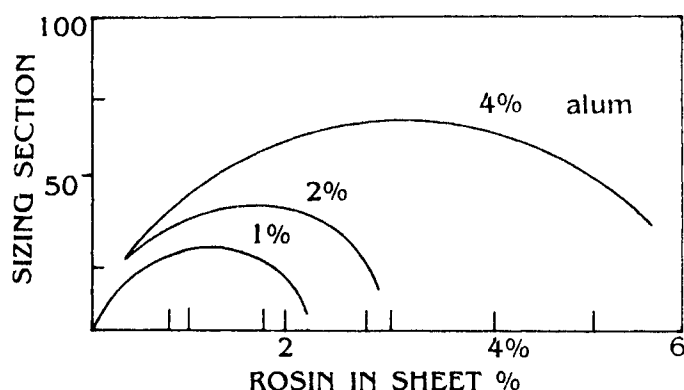
Since the ionization of H_2SO_4 is greater than that of aluminium hydroxide, the final solution is acid, buffering around a pH of 4.0 although pH values as low as 2.5 may be obtained. This acidity of alum serves to acidify the sodium resinate present in the size and to neutralize any alkaline materials in the pulp and water suspension. The important points to consider as far as the composition of the alum solution is concerned are total solids content, pH value, total acidity, and alumina content. Steps should be taken to control these variables in case any appreciable fluctuations occur.

The amount of alum used to set rosin size depends upon the amount of size, the character of the stock being sized, the character of the water, and the amount of re-used water. In practice about 1.5 to 2.0 parts of alum per part of rosin size are required to obtain proper sizing, although the theoretical amount of alum required to react with and precipitate rosin size is far below this (about 0.35 part of alum per parts of rosin size). The fact indicates that more than a simple chemical reaction between rosin size and alum is involved.

The results of Wilson and Dutson, reproduced in figure below show that the ink resistance tends to increase as the amount of alum in the furnish is increased from 1 to 4% when the

PRESERVATION OF DOCUMENTS

per cent rosin (as rosin) in the paper is varied from 0 to 6%. These results show that a high percentage of rosin size is valueless unless there is sufficient alum to react with the size, when highly sized paper is made.



Effect of alum (Percentage on Curves) on ink resistance ink papers containing different amounts of rosin foaming may occur and the sheet may stick on the press. These troubles can often be overcome by adding more alum. The use of alum alone in ground wood furnished can result in some ink and water resistance when the pulp has a high resin content.

The mechanism by which alum "sets" rosin size is highly important to the paper chemist. One of the obvious roles of alum in sizing is to precipitate the rosin size has arisen over the nature of the rosin size precipitate. At the time of discovery of rosin sizing in 1807, Illing believed that the rosin size was precipitated as free rosin and that this free rosin, as such, was the active sizing agent. Since that time, other investigators have proposed that the active sizing agent is not free rosin, but aluminium resinate, while others have maintained that both free rosin and aluminium resinate must be present to obtain satisfactory sizing.

PRESERVATION OF DOCUMENTS

A material of the composition of aluminium diresinate, $\text{Al}(\text{C}_{29}\text{H}_{29}\text{O}_2)_2\text{OH}$, was found in papers sized with standard rosin size. In addition free rosin was also present in the precipitate to the extent of that initially present, plus that formed by the reaction between sodium resinate and alum. Kaltenbach claims that sodium resinate combines with alum in water to form aluminium hydroxide and free rosin and then combine on the paper machine driers to form aluminium resinate. The presence of aluminium in the precipitate increases the water repellency over that obtained with the rosin acid by itself.

In addition to its role in precipitating rosin size, alum is also involved in a complex mechanism by which the rosin size precipitate is attached to the fibers. Many theories and variations of theories have been proposed to explain the mechanism by which rosin size precipitate is fixed on the fibres, but in general, these may be summarised into two general theories, namely, the alumina theory and the aluminium ion or Co-ordination theory.

PRESERVATION OF DOCUMENTS

ACCUMULATION OF ACIDITY IN PAPER

Cellulose fibres malted together forms basic structure of paper. Cellulose is the most widely distributed plant polysaccharide. It forms the main constituent of the cell walls of plants. Cellulose is in association with hemicellulose (lower molecular weight cellulose like polysaccharide) and lignin (a non carbohydrate aromatic polymer) constitute the structural material of woody plants.

Chief element of the paper consists of indefinite number of glucose formed cellulose. $(C_6H_{10}O_5)_n$

Influence of acid on cellulose; an acid chemically reacts with cellulose as a result of polymer chain link of cellulose breaks down and paper becomes brittle.

Paper gathers acidity due to influence of two factors :—
(a) Internal factors which are established primarily by the composition of paper and (b) External factors, for example Temperature, Relative Humidity (which control the hygroscopic moisture content of the sheets exposure to light atmosphere, U.V. Rays contamination SO_2 , NO , H_2S) etc.

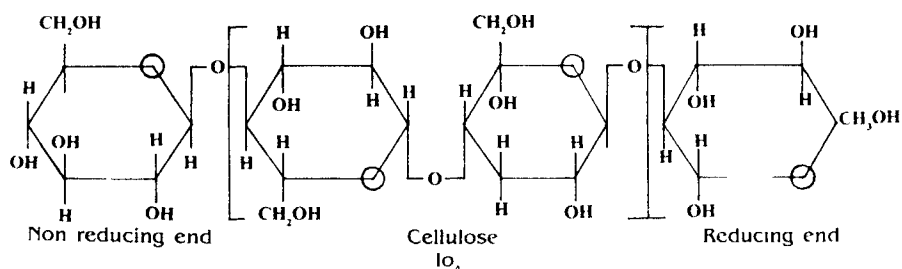
Cellulose is oxidised by the atmosphere oxygen although under normal condition, the rate of oxidation is slow. Oxidation leads to form action of carbonyl (reduction) group and of carboxyl (acidic) groups at one or more location in the glucose unit which disintegrate the cellulose chain molecules. Oxidation of cellulose results in formation of peroxide which contributes further oxidation and side reactions.

Ozone in the atmosphere even in minute concentration is a very active deterioration reagent. The formation of oxidation product may be accompanied by immediate disintegration of

PRESERVATION OF DOCUMENTS

the polymeric chain molecule.

Structure of cellulose fibres changes due to oxidation and formation of oxycellulose. While acid disintegrate cellulose tissue, the product is termed hydrocellulose. The hydrolysis of cellulose by acid attack leads to decrease in length of the polymeric chain molecule through random division of the chain.



The strength of the fibre is decreased, deterioration may proceed so far that the fibre becomes very weak and brittle and finally can be reduced to a fine powder.

Hydrolysis may be caused by the presence of acid introduced into the paper during manufacturing, for example, Alum (double sulphate of aluminium) used in sizing forms chlorides which may be present in paper as residual chlorine or hydrochlorides used for bleaching. Thus aluminium chloride particularly in the presence of heat and moisture produces HCl, one of the harmful agents that attack paper fibres. Oxidised cellulose or

PRESERVATION OF DOCUMENTS

the acid hemicellulose associated with the cellulose in wood pulps contains carboxyl (acid) groups, which are a part of the polysaccharide chain molecule wood contain accetyl groups. Hydrolysis of these groups in wood or in pulps from which they have not been removed introduces additional acidity. External sources of acids arise from atmosphere of urban or industrial areas that may contain SO_2 , which is readily oxidised to H_2SO_4 and oxides of Nitrogen which form HNO_3 . These atmospheric sources contribute to acid deterioration. From the statistical data of air-pollution in Calcutta contains about 1299 metric tons per day of which 440 tons of CO_2 , 122 tons of SO_2 , 102 tons of Hydrocarbons, 70 tons of Nitrogenoxide. It is clear from this observation that the magnitude of acidic gases deteriorate the book papers very quickly.

The extent of hydrolytic reaction depends upon the amount of acidic substances which are originally present in the paper. The contribution of such acids to deteriorate is minimized if the paper contains buffering materials (a buffer solution is one which resist the changes in p^n when acids or alkalies are added).

Alum reacts with water vapour (H_2O) produced Al^{++} ion and H_2SO_3 next stage it becomes H_2SO_4

During the period of manufacturing of paper, chloride and hydrochlorides used this residual chlorine (Cl_2), react with Al^{++} . $2\text{Al} + 3\text{Cl}_2 = 2\text{AlCl}_3$. AlCl_3 react with water vapour (H_2O) forms $\text{AlCl}_3 + 3\text{H}_2\text{O} = \text{Al}(\text{OH})_3 + 3\text{HCl}$.

Nitric oxide (NO_2) molecule dimerise forms N_2O_4 molecule and react water vapour form HNO_3 , $\text{NO}_2 + \text{NO}_2 = \text{N}_2\text{O}_4$

$\text{N}_2\text{O}_4 + \text{H}_2\text{O} = \text{HNO}_3 + \text{HNO}_2$

PRESERVATION OF DOCUMENTS

Deterioration of cellulose by chemical reaction of oxidation or hydrolysis is more rapidly by increasing temperature.

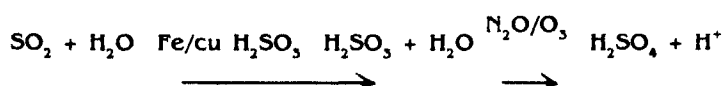
Hydrolysis and oxidation generally proceeds more rapidly in the presence of moisture. Paper is hygroscopic and has a moisture content of 5-7 percent in equilibrium with relative humidity.

Deterioration is promoted by the presence of many metallic salts particularly those of SO_2 in presence of water vapour, iron and copper which produced H_2SO_3 . Iron and copper which are unavoidably introduced in small but measurable amounts during manufacturing processes. Cellulose is degraded photochemically, but lignin is especially subject to deterioration from this source. Paper containing ground wood which observed to have poor stability upon exposure to light, particularly to strong ultraviolet sources.

Paper may absorb from acidic ink with which they were printed or written upon. Wrongly tanned leather if used without testing may also impart the acidity of the books.

In the early forties, Barrow recognised that the built in acidity of paper had a greater effect on its deterioration than atmospheric contamination and advocated the deacidification of documents. In 1969, the problem was reviewed and examined by Smith. In addition, a number of workers throughout the world have contributed much to our present knowledge of deterioration due to acidity which accommodate of acid perceptive measure and deacidification processes.

This H_2SO_3 in the 2nd stage reacts with N_2O nitricoxide and iron as catalyst and forms $\text{H}_2\text{SO}_4 + \text{H}^+$



PRESERVATION OF DOCUMENTS

It has been observed by Smith that the p^H value for stable permanent paper has altered with the passage of time. In the early twentieth century, permanent book papers required a p^H of 4 (hot water contact). In 1928, this figure was set at 4.7. By 1935, it was realized that low p^H was a cause of early deterioration in paper and the figure was raised to a minimum p^H of 5 for good quality book paper. In 1937, the figure was raised by Grants to p^H 6. He observed that for permanent paper, the value of the hot water extract should be less p^H . In 1959, Lewis stated on the basis of tests that papers in good condition had a p^H of 6.3 and 6.5. Later Barrow also stated that the most stable paper shows a p^H of about 7 (cold extraction) while the least stable shows a p^H of 5, and that a p^H of about 6 is desirable for maximum conservation.

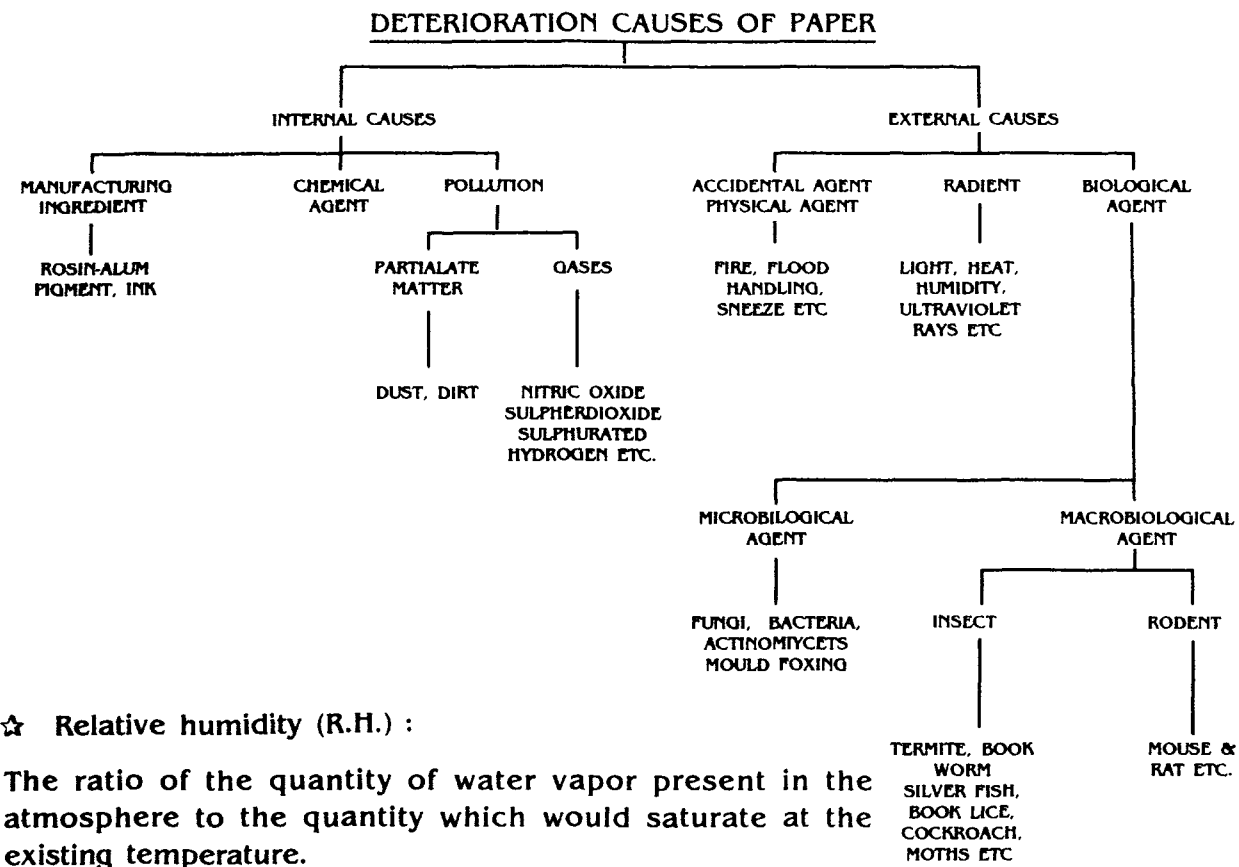
Smith suggests that the most desirable p^H value is 7 i.e. neutral. An evaluation by Kath Palia of papers dating from the 14 to 19th centuries has shown that papers with p^H above 6.7 are in excellent condition while those with p^H ranging from 6.2 to 6.7 are good condition and that all these papers are free from fungus strains.

It is now well known that a p^H of 4 is too acidic for papers. Under this conditions it becomes brittle rapidly. It is also known that if paper is to resist fungus growth, it should be slightly acidic. In 1959, Barrow developed a grade of paper from chemical wood, which has a p^H of 9 and on the basis of tests may be expected to last for approximately 300 years. It would thus appear that a p^H value of about 7 is most suitable for permanent papers and should be incorporated into standards for such papers.

As a result of the studies referred to above, a number of processes have been developed which effectively neutralize the deterioration action of free activity in paper. The various

PRESERVATION OF DOCUMENTS

processes developed may be classified either under wet or dry and various methods.



☆ Relative humidity (R.H.) :

The ratio of the quantity of water vapor present in the atmosphere to the quantity which would saturate at the existing temperature.

PRESERVATION OF DOCUMENTS

DETERMINATION OF pH & DEACIDIFICATION

The most convenient method of expressing the relationship between H⁺ and OH⁻ is pH. Definition of p^h is the logarithm of the reciprocal of the hydrogen ion concentration in grams per litre usually written

p^h = Log 1 / (H)⁺

At neutrality, the hydrogen ion conc. is .0000001 of 10⁻⁷ grams of hydrogen per litre of solution. This is expressed in the formula.

p^h = Log 1 / .0000001
= Log 1000000
= 7

At a p^h of 6, there is .0000001 gm. of active hydrogen or 10 times the concentration of H⁺ than at a p^h of 7. At each smaller p^h unit, the (H⁺) increases by 10 in conc, It, therefore, follows that a p^h of 6 is 10 times more acid than a p^h of 7, a p^h of 5 is 10 times more acid than a p^h of 6 so on.

If p^h concept permits the expression of the H⁺ ion conc. on a scale of acidity of alkalinity from 0 to 14.

Usually p^h values :— An approximate idea of the p^h is that a solution at about 25°C can be obtained at a glance from the following :

Hcl															NaOH				
1N	N	N	N	N											N	N	N	N	1N
	10	100	1000	10000											10000	1000	100	10	
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14					

PRESERVATION OF DOCUMENTS

$p^H = 3$ means an acid solution, having the same acidity as a $N/10000$ HCl soln: $p^H = 11$ means an alkaline solution having its alkalinity as a $N/1000$ NaOH solution $p^H = 2.3$ means acidity between centinormal and a thousandth normal HCl solution. Through the p^H of solution lie between 0 & 14. In pure water $H^+ = 10^{-7}(N)$ $p^H = -\text{Log}_{10}H^+ = -\text{Log } 10^{-7} = 7$

$$\text{In } N/50 \text{ HCl } (H^+) = 0.02N \quad p^H = -\text{Log } 10 (0.02) = 1.7$$

$$N/200 \text{ HCl } (H^+) = 0.05N \quad p^H = -\text{Log } 10 (0.05) = 2.3$$

$$\text{In } N/1000 \text{ NaOH } (OH^-) = 10^{-3} \quad \therefore (H^+) KW/OH^- = 10^{-14}/10^{-3} = 10^{-11}$$

$$\therefore p^H = (-) \text{Log } 10^{-11} = 11$$

pH is determined by pH meter, lovibone comparature & result can be obtained precision with the electronic pH meter. Estimating the acidity accumulate in old paper, one of the deacidification method is adopted.



p^H Metre

PRESERVATION OF DOCUMENTS

Deacidification

Deacidification is key point of preservation. It is a curative mechanism to stop further hydrolysis of the cellulose structure in paper. Acid mostly breaks down the cellulose polymer chain reducing the strength of paper. Strong alkali is also dangerous of ion as well as acid.

There are 10 methods of deacidification of which aqueous, non-aqueous and gaseous deacidification are in vogue according to the need and condition, size of the document.

Wash with water

Before aqueous deacidification document should be washed with fresh water, provided the document is not too brittle. The acidic ingredients in paper and degradation products due to hydrolysis are mostly water soluble, old paper generally become yellowish and brown due to oxidation of lignin (impurity in paper). Water soluble ingredients come out during wash with water and paper regain whiteness to some extent. The p^H of the paper reached 5.5 after washing whereas initially it was p^H 4.4. Some of the hydroxyl group (OH) of cellulose get oxidised to carboxyl group (-COOH) making Oxycelluloses. These Oxycelluloses have their proton (H^+) exchanged with metal ions (Al^{+++} , Ca^{++}) and have acidic nature. After repeated washing the paper with aluminium ion gives pH 5.3 and that with calcium ion p^H 6.8.

Aqueous Deacidification

Alkali solution neutralises the acidity in paper. The hydroxides are more strongly alkaline, insoluble, unstable and have deleterious effect on paper and have therefore not been considered satisfactory. The hydroxides of second group specially of calcium and barium have been found more

PRESERVATION OF DOCUMENTS

suitable because of their high solubility in water.

Barium hydroxide according to M. Hey in water carbonates with the carbondioxide so fast that the solution becomes opaque with barium carbonate which is insoluble in water. Too brittle document cannot be preserved by this method. Antiquities such as newspapers which are slightly large size, too brittle documents, cannot be deacidified with this method.



Acqueous deacidification

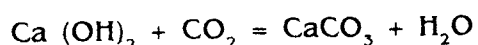
CALCIUM HYDROXIDE AND CALCIUM BICARBONATE $\text{Ca}(\text{OH})_2$
and $\text{Ca}(\text{HCO}_3)_2$

PRESERVATION OF DOCUMENTS

(Borrow's method)

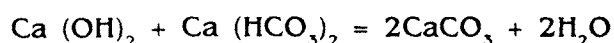
Calcium Hydroxide solution (I)

To about half a kilogram of good quality of Calcium oxide is taken in a 30 litres capacity plastic drum. 2-3 litres water is gradually added till 25 litres to form a milky cream. The lime in excess is allowed to settle and the drained liquid which is taken in large tray by enamel mug. The document is immersed in the calcium hydroxide solution and keep in for half an hour. In the same manner 25 litres of fresh water is added again to the drum with stirring. The same lime can be used for preparation of calcium hydroxide solution. 50 sheets can be immersed in the same tray.



Calcium bicarbonate Solution (II)

After half an hour the sheets are removed, excess of calcium hydroxide drained, and the sheets immersed in calcium bicarbonate solution for 30 minutes, Calcium bicarbonate readily converts the hydroxide into calcium carbonate.



The residual calcium carbonate in paper slows down further hydrolysis and acts as buffer action.

About 30 litres calcium bicarbonate solution can be prepared by passing 45 minutes carbondioxide gas to a solution of calcium hydroxide. At first a milky suspension of calcium carbonate is formed. On passing the carbondioxide continuously it changes to clear solution of calcium bicarbonate.

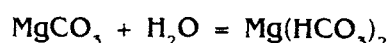
Doubts have also been raised over about the second stage of treatment in calcium bicarbonate solution of 0.15% strength of

PRESERVATION OF DOCUMENTS

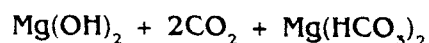
the relatively alkaline documents. The relatively alkaline document treated in $\text{Ca}(\text{OH})_2$ on being immersed in the dilute $\text{Ca}(\text{HCO}_3)_2$ loses most of its alkalinity and very little is left over as calcium carbonate precipitate. Anne and Jacob have shown the rise of pH which was much less after treatment with calcium bicarbonate treatment than with calcium hydroxide alone. It is therefore, better to air dry the acidified document after calcium hydroxide treatment alternatively in atmosphere of CO_2 for rapid conversion to Calcium bicarbonate.

Magnesium Bi-carbonate

Deacidification of documents can be conducted by immersion method and also by spray method for whole book in each bound volumes individual. A suspension of 25 gms of MgCO_3 is taken in one litre of water. CO_2 gas is passed continuously till a clear solution is obtained.



Magnesium hydroxide can also be used for preparation of magnesium bicarbonate.



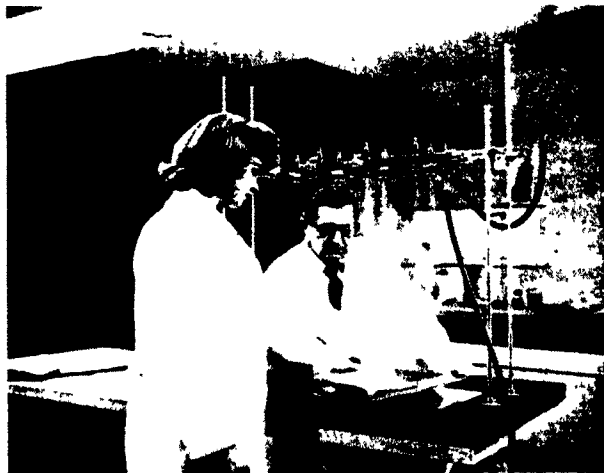
The solution of MgCO_3 in water by passing carbondioxide is ten times more soluble than that of calcium carbonate. The solution of $\text{Mg}(\text{HCO}_3)_2$ tends to become milky on standing and therefore fresh solution should be used. The pH range of the solution is from 6.4 to 9.5 depending upon the concentration of carbondioxide and Magnesium Carbonate. The total immersion method has an advantage as it removes the oxidation products. The papers treated with $\text{Mg}(\text{HCO}_3)_2$ is of higher pH than water and $\text{Mg}(\text{HCO}_3)_2$.

PRESERVATION OF DOCUMENTS

Deacidification through spraying

The spraying deacidifier consists of 8 nozzles in two rows four to five inches apart from each other. Container of the chemical must be acrylic whose capacity is about 10 liters. The mixture of magnesium bicarbonate, alcohol and water is required to atomize by means of air compressure to form very light spray or mist. Mr. Barrow observed that the life of the papers are increased by this treatment about six times. The treated paper had a pH 6.1 to 8.7 and exhibited a normal decline after 24 days of heat-aging.

It is a rapid method of deacidification for weak documents. This method is considered as semi mass deacidification. Ten normal size books can be exposed to chemical treatment per man per day.



Mrs. Turner demonstrates the apparatus used for deacidification of books, manuscripts, etc. by spraying while Mr. Barrow observes.

Spray deacidification

PRESERVATION OF DOCUMENTS

Gaseous Deacidification

Ammonia is found alkaline enough to neutralize the acid in paper. Old brittle rare newspaper can be deacidified with this method. The gas must reach to every part in the book. There should not be any residue left to make the paper smell or toxic. It should not affect the brightness of paper on standing and the life of paper should be enhanced.

Ammonia NH_3

Ammonia is in gaseous form which can be used to raise the pH to about 8. A 10% solution of ammonia is kept in a reasonably leak proof chamber and the documents are so arranged that they get enveloped in the gas ensuring. A pH of 8 is attended after 48 hours. The ammonium salt so produced are however, unstable and tend to decompose. Process is required to repeat periodically.

CYCLO-HEXYLAMINE $\text{C}_6\text{H}_{11}\text{NH}_2$

Langwell developed the process of deacidification of a whole publications with cyclohexylamine carbonate. The process may therefore be thought to be useful for large scale deacidification. Papers impregnated with cyclohexylamine carbonate are entered into the book at an interval of about 25 sheets. The gaseous cyclohexylamine diffuses into the whole book and deacidifies it in about 3 days.

This method enhances the pH , as a result it increases folding, tensile and bursting strength. It has adverse effect on resin sizing and brightness of paper. It does not leave any residue to counter future development of acidity. It is a dangerous chemical which is toxic to workers and users.

PRESERVATION OF DOCUMENTS

MORPHOLINE $\text{NH-CH}_2\text{-NH-CH}_2\text{-CH}_2$

It is dynamic process of deacidification which is reversible and requires treatment again after a few years. The fumigation with morpholine requires evacuation of books in a vacuum chamber to eliminate water content while keeping it warm. Mixture of water and morpholine is introduced into the chamber and circulated at a reduced pressure of 30 mm of Hg for 10 minutes. Under low pressure the chemical enters well into the books and deacidifies the paper. Excess absorption of the chemicals by the book covers makes it sticky and therefore the exposure time is kept under control. Finally the chamber and books are thoroughly aerated.

DRY OR NON-AQUEOUS DEACIDIFICATION

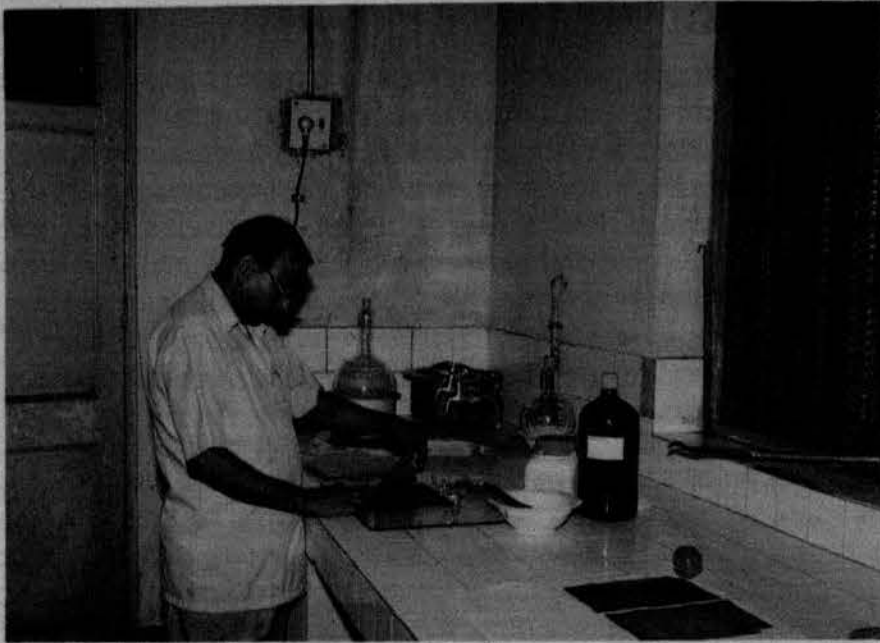
In case of brittle document, dry process is suitable for deacidification. The manuscript which is used for water soluble ink or colour is required to deacidify with alkaline solution. In very rare cases, ink or colour fixative polymer solution is used before deacidification of document.

BARIUM HYDROXIDE-OCTAHYDRATE : $\text{Ba(OH)}_2 \cdot 8\text{H}_2\text{O}$

The barium hydroxide is soluble in methanol. A solution of 10 gms of this is made in 1 litre of methanol and is applied on the document by brushing. The solution is used in case of too brittle documents. Methanol takes the hydroxide into the paper where it is gradually converted to barium carbonate raising the pH to about 7.6.

This method, however, cannot remove the degradation products like polygluconic acid, which tends to reverse the paper to acidic condition. It cannot be adopted for large scale deacidification. Methanol is dangerous and toxic, while the barium carbonate precipitated on the paper is poisonous on ingestion.

PRESERVATION OF DOCUMENTS



Dry deacidification

MASS DEACIDIFICATION

Deterioration of paper materials is dynamic process as a result of cumulative effect, it becomes damage in course of time which is necessitated by mass deacidification. The physical conservation is the slow, manual, individualistic, cumbersome, requiring complete dismantling of a book and reassembling besides being threatened with the toxic nature of deacidifying agents and their products.

Most of the papers prepared mechanically in India are used for printing, writing, etc. and p^H is about 5.5. The collection of National Library, Calcutta is about 2.5 million of which 10%

PRESERVATION OF DOCUMENTS

rare and brittle needed physical preservation deacidification of sheet by sheet. The resources of the country are limited to meet these requirements of the National Library and other repositories. Collections in most of the libraries and archives are languishing and gasping for survival. The deacidification process so far dealt, can help small collections in the museum where the problems are limited.

To meet the national need, a two-pronged method is necessary (1) Production of better quality and alkaline paper (2) Mass deacidification of all existing materials. So far the country has no system for either. Production of good paper is a concern of planning and paper technologists but the mass deacidification is to be worked out by the conservators indigenously and to be adopted. At the international level two processes are available as discussed below.

DIETHYL ZINC (C_2H_5O)₂Zn

Library of Congress, Washington has extensively worked on the possibilities of using diethyl zinc as deacidifying agent. The process consists of drying the book in Vacuum Chamber for 3 days at a raised temperature of 45°C (The capacity of the chamber can be made upto 5000 books). This is essential to avoid violent reaction. The diethyl zinc in gaseous form equal to 3% of the weight of the books is introduced into the chamber. The pressure rises to about 35mm of Hg. The vapours of diethyl zinc penetrate into the paper and neutralize the acid and get the paper buffered in 3 days time. When the reaction is over, the excess of diethyl zinc is completely removed with alcohol. When free from the diethyl zinc water is added by 3% of the weight of the books and carbondioxide is introduced till the pressure becomes normal. This is continued for 3 days. Inside gases of the chamber are now

PRESERVATION OF DOCUMENTS

carbondioxide and ethane which are evacuated and washed with air.

The diethyl zinc which gets into the fibres of paper reacts with the water vapour and forms Zn(OH)_2 , which in turn reacts with carbondioxide and form zinc carbonate.

MAGNESIUM METHOXIDE (CH_3O)₂ Mg

This is a non-aqueous and non-gaseous method more popularly known as Wei T'o method on the name of an ancient Chinese God assignment to protect books against hazards.

A firm by name Wei T'o in Canada developed this process in 1979. Magnesium methoxide is soluble in water methanol

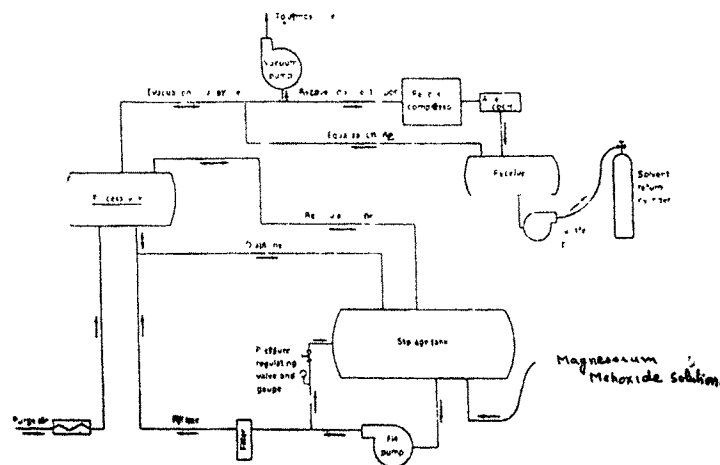


Diagram of wei TO -Non-aqueous book Decidification System

PRESERVATION OF DOCUMENTS

and di-chloro fluoromethane and is stable upto 8% solution. Magnesium methoxide is introduced into the paper in excess to check future development of acidity also.

The chemical reaction on paper forms magnesium carbonate and magnesium hydroxide. Subsequently these two ingredients react with CO_2 and water vapour to form the magnesium bicarbonate. The precipitation of magnesium hydroxide on paper inhibits the catalytic activity of the trace metals iron, copper etc. in oxidizing cellulose fibre. This has another advantage that the iron is inhibited to combine with moulds and staining of paper (foxing) is prevented. The main neutralization reaction with the sulphuric acid leaves magnesium-sulphate in the paper as is the case with magnesium bicarbonate, which has no deleterious effect.

Deacidification with Magnesium methoxide involves the following operations :

1. Selection and loading of books on crates.
2. Drying the loaded books in dry air for 24 hours.
3. Complete drying in vacuum for over night.
4. Making of Non-aqueous deacidification solution in methanol or dichlorofluoromethane.

The above processes are preparatory to deacidification. The deacidification is carried out in the plant as shown in the sketch. In this process the following steps are taken :

1. Load the dried book in the process tank.
2. Evacuate the air from the process tank.
3. Pressurize the process tank with the recovered vapour of the solvent.

PRESERVATION OF DOCUMENTS

4. Fill the process tank with the liquified deacidification solution.
5. Impregnate the deacidification solution by raising the pressure.
6. Reduce the pressure and remove the unused solution from the process tank.
7. Commence drying by evacuating the process tank and recover and condense the solvent vapours.
8. Complete drying by vacuum and discarding residual solvent.
9. Equalise pressure and purge the process tank with warm air.
10. Open the process tank and remove the books and seal them in paper carbons.
11. Allow the books to stand over night and then inspect.

To work with the Kipp's Apparatus, the rubber stopper, attached to the central globe is taken out and small pieces of the substance marble in the case of CO_2 are introduced into this globe. The rubber stopper is replaced and the glass stop-cock in it is opened. Cold dilute acid. (HCl) is poured down the upper globe till the acid entirely fills the lower most globe and covers the substance in the central globe. As soon as the acid comes in contact with the substance in the central globe the gas generated which comes out of the stop-cock. If the gas is not required, the stop-cock is closed. When the gas collects in the central globe, When the acid rises up the steam and goes into the upper globe. Thus the substance not being in contact with the acid further the action is stopped. When the gas is required the stop-cock is opened and the gas

PRESERVATION OF DOCUMENTS

inside the central globe escapes. Pressure is released the acid once more comes in contact with the calcium carbonate and one gets steady supply of the carbon dioxide again



Kipp's Apparatus

ACIDITY AND ALKALINITY

An acid may be defined as a substance which forms hydrogen ions when dissolved in water. Where as an alkali forms hydroxyl ions when dissolved in water. Acids and alkalis are capable of neutralizing one another to form salts.

Colour of Indicator		Value of p ^H
Red	very old	3 - 4
Orange	Moderated 5.5	5 - 5.4

PRESERVATION OF DOCUMENTS

Yellow	slightly acid	6-6.5
Greenish yellow	neutral	7-7.5
Green	slighly alkaline	8
Bluish green	moderately alkaline	8.5
Blue	very alkaline	9.5
Violet	Intensely alkaline	10-12

PRESERVATION OF DOCUMENTS

REPAIR AND RESTORATION OF MANUSCRIPTS

Traditionally people used to write on clay, stones, copper plates, papyrus, parchment, vellum, wooden tables, birch bark, palm leaf and cloth etc. prior to invention of paper.

These early hand written documents are very precious and important to us as evidence of old culture. These documents give us valuable information and are called manuscripts.

Most of these manuscripts generally are too brittle and fragile which need treatment to upkeep the intellectual & cultural heritage for the posterity of the country.

Most documents which have been cleaned, washed or deacidified and flattened, require either resizing or minor repairs, to restore their mechanical strength. Documents which have yellowed or become brittle and are in an advanced state of deterioration require more extensive repairs. A number of processes are employed for reinforcing such documents, namely : (a) tissue repairing; (b) chiffon repairing (or silking); (c) mounting; (d) inlaying; (e) machine lamination; (f) solvent lamination; (g) Tissue lamination; (h) Polythene lamination; (i) Delamination; (j) Preservation of leather bound volume; (k) Restoration of coloured illustration etc. All these processes have certain disadvantages and limitation. Their use, therefore, depends on the nature of the document, its constituent materials and the extent of damage. The work of reinforcement requires considerable skill and its quality and effectiveness will depend on the knowledge and experience of the restorer.

PRESERVATION OF DOCUMENTS

Principles of Repairing

It is essential to follow certain principles of repair before restoration is attempted. These are :

1. The originality of the document should not be disturbed in any way and the repair must be neat and tidy.
2. The nature and extent of repair should be evident.
3. The writing should not be marred or impaired in any way.
4. The process applied should be reversible.
5. The process adopted should provide maximum reinforcement at minimum cost.
6. Methods used for repair should be durable and permanent.

Tissue repairing

Part tissue

Documents which are torn slightly, brittle a portion during handling needs part tissue to make it usable. The torn portion of document is deacidified with calcium hydroxide solution. Weted it with a piece of cotton swab keeping blotter on the reverse of the treated page. A piece of lens tissue paper is cut down according to the size of the torn portion. Now carboxy methyl cellulose is pasted on the document and sticked tissue paper on the torn portion of the document.

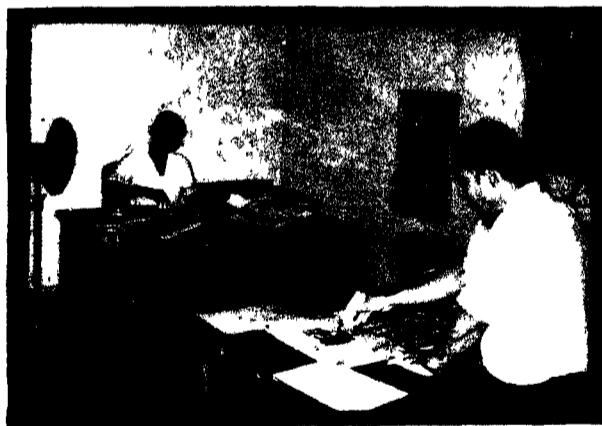
Tissue Lamination

The use of Indian tissue Paper in the country is an age old practice which is not at all durable. It is a very easy method which is adopted in big libraries. The National Library, Calcutta using imported lens tissue paper (pH = 6.5 cellulose contining

PRESERVATION OF DOCUMENTS

88%, thickness .01mm) which are available in the market. The superior quality paper is being used incase of manuscripts and rare materials in this Library. The following salient points are to be taken into consideration to follow before lamination.

1. Examination of document and pagination
2. Spine of the document is cut down slightly without disturbing the written portion.
3. Preparation of hand made paper strip, 3-6 cm on width for using as guard, while length is according to the size of the document.
4. Preparation of tissue paper is slightly larger than the size of the document.
5. Preparation of Dextrine paste or carboxy methyl cellulose 3%. The C.M.C is non-acidic in character and it is most suitable paste.
6. Method of deacidification is required to adopt according to the condition of the document.



Tissue Lamination

PRESERVATION OF DOCUMENTS

Procedure

The deacidified page 1 and 8 are placed on the glass top table at a distance of 4/5 cm gap. A hand made paper guard (4/5 cm) is placed in between two pages for reinforcement of the document. The cooked C.M.C. is pasted on the both pages and guard. Then the "sized lens tissue" is placed from left end to right end of the document and slightly soft cloth pressure should be exerted so that air bubble cannot persist in the laminated sheet. One side laminated sheet is inverted with a knife. The reverse side is pasted C.M.C. with a soft brush and the other three sets, the pages 2 to 7, 3 to 6 and 4 to 5, are laminated in similarly way. It is collated after drying and cutting one section is prepared and so on. The cutting should be made 1mm apart from the document.

LAMINATION WITH MACHINE

Procedure

A composition or envelope is prepared by assembling the sheet of the book and material in the following order : tissue paper, cellulose acetate film and document then same way at the reverse.

Handmade paper used as a guard in between the sheet 1 and 8, 2 and 7, 3 and 6 and 4 and 5 respectively of a section for strengthening of the document.

On lamination, this gap portion (laminated tissue) becomes strong enough to serve the purpose of guard for stitching the documents into file covers. For the purpose of binding a volume, the laminated guard can be strengthened by putting in a slip of either bond paper or hand made paper.

During the preparation of a composition or envelope of paired

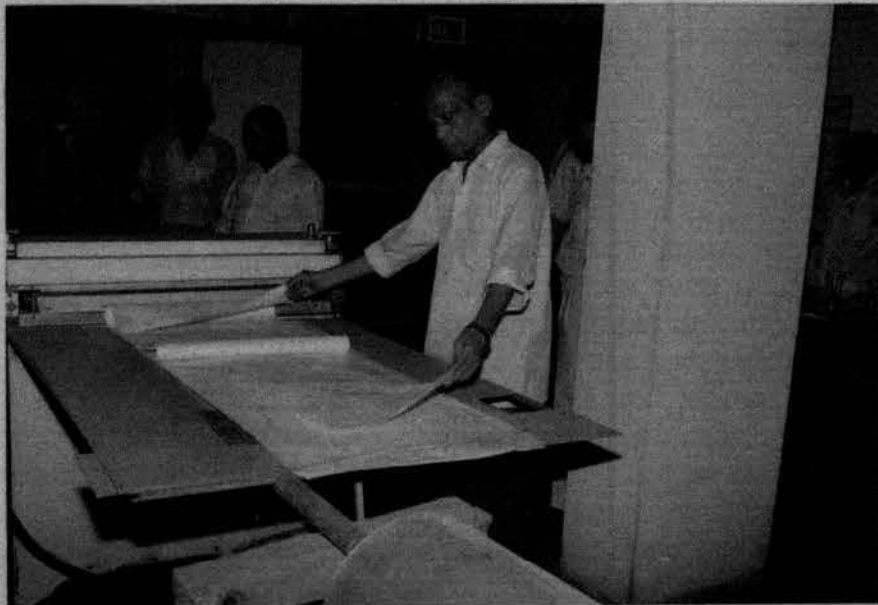
PRESERVATION OF DOCUMENTS

documents as described above, all loose fragments and the documents should be fastened to the acetate film with a finger dipped in acetone. Each composition or envelope is then placed between two sheets of "Teflon" (tetrafluorethylene), a synthetic resincoated glass fabric before feeding it into the press. 40 sheets of normal size book can be laminated by Machine Implex lamination within 1 to 2 minutes at 150°C – 160°C Temperature and 25–40 kg/cm² pressure.

Trimming of the laminated sheet and then collation of sheets ready for binding.

SOLVENT LAMINATION

Procedure : The following steps are adopted for five ply



Operation of Laminator Machine

PRESERVATION OF DOCUMENTS

sandwich (tissue, acetate film, document-acetate film, tissue) or envelope preparation.

The book is examined for ascertaining lamination process.

It is deacidified according to condition of which is deemed to be fit. Tissue paper, cellulose acetate film, and hand made paper are cut down according to size of book. Then strong paper is used for preparation of filler for missing portion.

Then preparation of envelope is made for solvent lamination as well as machine lamination. The materials are cut to the required size and sandwich of the document cellulose acetate film, tissue paper. The composition is placed on a glass topped table for use of its smooth surface.

A moderate amount of acetone is then applied by means of surgical cotton or nonlinting cloth to the top surface of the sandwich, slowly and evenly and with a little pressure from the centre towards the edges. The acetone soaks through the tissue paper and converts the cellulose acetate film into a gel form. The cotton swab is now free of excess acetone, which is quickly rubbed with a little more pressure over the surface of the document. This operation takes 15 to 20 seconds. The sandwich is lifted and inverted so that the other surface may similarly be treated. The treated document is allowed to dry for a further five seconds and rubbed with the base of the hand to remove any air bubbles and to ensure that the tissue paper has bound to the surface properly. The laminated sheets (two to four) are then interleaved with waxed paper and placed in a nipping press to ensure a smooth surface and to remove any creases or air gaps that may be caused during the process of repair.

PRESERVATION OF DOCUMENTS

DELAMINATION

Procedure

Since Lamination is reversible process, sometimes manuscripts to be needed delamination for further lamination by modern method. The spine of the book is opened with knife. Then adhesive and ink of document are tested. Accordingly, water (hot or cold) and petrol are to be used successively one after another. Treatment is selected according to document. Hot water should not be more than 60°C temperature which damages the cellulose. The document is washed and dried.

PRESERVATION OF LEATHER BOUND VOLUME

Procedure

A leather bound document which is in crumbling state due to rough weather is collected and cleaned with soft cloth. Then applied 10% sodium benzonate water solution for perfect cleaning and kept it dry for 12 hours. Then leather preservative mixture which was prepared separately is applied on the leather bound volume and rubbed the same with soft cloth. In order to dry, the mixture of the document is kept under open air for 24 hours.

PRESERVATION OF DOCUMENTS

RESTORATION OF COLOURED ILLUSTRATION

Procedure

First test the colour, whether it is water soluble or not. If the colour is water soluble, fix the colour with 3% polyvinyl alcohol solution in toluene solvent. The illustration is deacidified according to condition and air dried. The illustration is covered with cellulose acetate foil and fix the foil on the reverse side keeping on boarder with the illustration. Then set up on the photo cartridge paste properly. Another photo cartridge is made counter in the middle slightly small size than the painting picture. The photo cartridge is placed on the picture and paste it in between two photo cartridges and it is processed through hot press. Last of all the document is trimmed according to size required.

FULL PASTING OF A PICTURE WITH NEPALESE HANDMADE PAPER

Procedure

The coloured picture should be tested whether water soluble or not. If water soluble, colour fixative agent polyvinyl acetate 2-3% solution in toluene solvent can be used. Deacidification is done through the reverse side of the picture. A handmade paper (larger size than the picture) is placed on the glass top and Carboxy Methyl Cellulose paste is used on the handmade paper. Another handmade paper is made countered according to size of the picture. This pasted frame is set up on the previous handmade paper one inch and a half is kept as boarder. The picture is placed under hot press.

The picture is deacidified and polyester encapsuled with both sides (double) adhesive tape. The encapsuled is sewed along the four sides of the picture.

PRESERVATION OF DOCUMENTS

MAP MOUNTING

Procedure

The map is deacidified according to condition. Polythene film is cut larger size than the map. The film is wetted and set up on the smooth working table so that air bubbles do not remain inside the polythene film. Then Nepalese handmade paper is wetted and set up on the polythene film. Paste is prepared with C.M.C. and Fevicol at the ratio 50% + 50%. The paste is applied on the Nepalese handmade paper with a fine brush. The back of wet map is set up on the Nepalese handmade paper. 5 to 6 cm wide Nepalese handmade paper is pasted on the four edges of the map. The map and the boarder is then covered with polythene film and pressed from the top to ensure proper adhesion of map and to remove any bubbles or crease left in the map. After drying, the excess backing Nepalese paper is trimmed off, leaving a 2 mm margin all around. In case of small and medium size map, Nepalese handmade paper is used instead of long cloth. It is cheaper than fine long cloth and its durability is almost same.

INK & COLOUR FIXATION

In case of water soluble ink and coloured document during deacidification, polyvinyl acetate, polyvinyl alcohol solution in toluene solvent is used as ink fixer in the National Library. But in developed countries like Britain, British Council Library used Paraloid B72 (Trade name) as ink fixer. A 10% solution of Paraloid B72 is used to consolidate weak or Triable surfaces of paper and parchment documents. This percentage is not to be used as a fixative for soluble inks, a 5% solution should be used for this.

PRESERVATION OF DOCUMENTS

MIXTURE

Take a 1000 ml. beaker and pour 700 ml. of Acetone into it. Place the beaker on the magnetic stirrer, put magnet in and switch on. While magnet is rotating, slowly pour 70g. of Paraloid crystals. Once the crystals have dissolved the mixture then it is ready for use. The application of the paraloid must be carried out in the fume cupboard and after use, brushes must be cleaned in Acetone.

STAIN TREATMENT

Procedure

i) Examination of Stain ii) Examination of the fibre quality of paper iii) Selection of suitable solvent from NH_4 , H_2O_2 & Chlorine water etc. iv) Treatment of Stain with the solvent under controlled condition v) Warm water washing treatment vi) Deacidification.

Paper pulp consists of straw, grass etc. which becomes yellow, brownish coloured due to huge impurities (lignin, Pectin) present in it. These documents are brittle in condition and deep in colour which cannot be preserved for either microfilming or lamination. Bleaching process is adopted for restoration of the documents. In this process very light dose 10% W/V chlorine water is sufficient for bleaching non-gel inks of the written document. The document is passed through 2% Sodium thiosulphate solution and wash with water repeatedly. Test with 1% silver nitrate (Ag NO_3) solution to determine whether residual chlorine is present or not. If white coloured residue appears, leach with pure water and add thiosulphate till the white precipitate present in the filtrate.

PRESERVATION OF DOCUMENTS

The following solvents are used to remove the stains :

Stain	Solvents
Carboxymethyl Cellulose paste	Warm water
Lacquer (Such as Cellulose acetate PVA)	Acetone
Inks	1% Oxalic acid
Wax and grease	1% Citric acid
Oil, fat and tar	Petrol, Pyridine, benzene
Mud, Tea, Coffee	Water, Ammonia
Mildew	Potassium Perborate, Ethyl alcohol
Adhesive tapes	Carbon tetra chloride, Benzene.

PRESERVATION OF DOCUMENTS

PARCHMENT AND VELLUM MANUSCRIPTS

The process for making vellum and parchment was supposed to have been developed about 190 B.C. in Asia Minor.

Vellum is a unborn calf skin which is preserved by soaking in a lime solution and carefully scrapped and polished. Vellum is much finer in texture than the average parchment. Carbon ink gold and silver paints were used for writing on them. Air conditioning system is the best method to preserve parchment and vellum manuscripts. Parchment and vellum manuscripts are stained by mildew.

- i) The stain is to be brushed off the loose pores and kill the embeded fungi by applying 10% thymol in methyl alcohol. Fumigation can be done with a dose of 1 oz. of thymol for 16 cubic feet space. The operation time is required for 14 days. Ink should be tested before using thymol solution.
- ii) Ethylene oxide and carbondioxide (1:9) are used as fumigant in vacuum chamber.
- iii) In humid region, thymolized blotting paper with help to protect the parchment or vellum manuscripts from mould.
- iv) A mixture of .5% chloro-m-crossed and .5% penta chlorophenol in alcohol.

Vellum text can be cleaned by erasing, using opaline rubbing "Pad" etc When washing is necessary it should be done with alcohol or solution of Lissapol-N in alcohol. Hydrogen peroxide some times, removes brown stain from parchment and vellum without effective writing.

PRESERVATION OF DOCUMENTS

The process for relaxing the manuscripts is done by hand washing and kept between damp blotters (after first testing the ink and colour) under glass for few days. As a precaution against mould, the blotters can be dampened with a solution of 0.25% Sodium pentachlorophenol. The final flattening is accomplished by placing the relaxed vellum between two clean dry blotters and insert this set in between glass plates and weight over it.

Badly wrinkled and deformed vellum MSS, will respond to flattening in a streacher after that it has to be released between damp blotters or in a humidity chambers.

Vellum in hard rolls and too severely distorted should be relaxed between blotters and made soft and flexible in a relaxing box and then flattened by pressure.

Hard folded parchment MSS can be opened after wetting in 50% alcohol or 10% alcohol urea solution. The opened document is then dressed with lanolin before stretching for several days and final pressing under weighted blotters for at best a week. Flaking off of ink or colour can be consolidated by brushing 5% solution of soluble Nylon in methyl alcohol or 2.5% Polyvinyl alcohol in toluene.

Holes in vellum are repaired by rubbing its edges and applying vellum patch. The patch is applied on the back of the hole which is cut just big enough to fill the aperature with no overlap. The repair is then kept under a weight until dry.

In lieu of adhesives, the edges of the damaged may be painted with 10% acetic acid. This gelatinizes the vellum under the weak acid so that when the form edges are rubbed together and dried before they get joined.

PRESERVATION OF DOCUMENTS

PALMLEAF MANUSCRIPT

Palmleaf was used as writing base before invention of paper in India during 7th to 12th century A.D. Palmleaf tree is common in South India, West Bengal and Bihar.

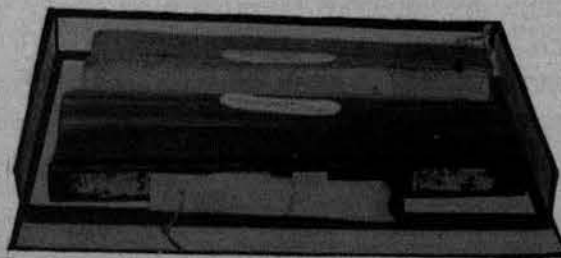
There are three varieties of Palm leaves in India.

(BORASSUS FLABELLIFER)

1) Talaleaf is thick and coarse. It does not absorb ink and therefore it has to be inscribed with a metallic stylus on its surface. To make the writing visible, the graphite powder with rectified spirit and water is applied on the surface.

Sritala (*Corypha umbracufera*) leaf is thin and flexible like paper and not easily attacked by the insects. It absorbs ink. Carbon ink has been used for writing on it. Palm tal (*Corypha*) leaf is less thick than Tala leaf. It is brownish in colour.

In South India a special treatment was given to palm leaf by applying gingili oil (Tin oil) to smoothen the surface and to adopt it for writing purpose. In Orissa there are three different methods of seasoning.



Upper portion treated

Lower portion untreated

PRESERVATION OF DOCUMENTS

SEPARATION OF LEAVES FROM A SOLID MASS

As a result of exposure to rain water or storage in humid condition, the palm leaves stick together, and become solid mass. For separation of palm leaves, the following methods can be adopted.

1. Palm leaves which have stuck together may be separated by placing them in a humidification room or exposing them to steam. When these have become sufficient moistured, each leaf is separated carefully by means of a blunt spatula.
2. Palm leaves may be separated by placing those in bath of hot water (60°C) containing 5 to 1% of glycerine. The water in the bath is changed every half an hour. After soaking for an hour, individual layers of leaf are lifted by means of a metallic spatula.
3. Palm leaves may be separated by immersion in a bath of hot (60°C) liquid paraffin.

Before cleaning a deacidification of palm leaves, text should be examined whether it is incised or not. The incised text should first be cleaned with a fine brush to remove the dust and then a mixture of rectified spirit and lime water (3:2) should be applied with a cotton swab along the fibre length on both the sides of the leaves. Whenever the ink is not washed in water, these could be cleaned with a solution of glycerine and water (1:10), where the ink is soluble in water, the same could be cleaned with carbon tetrachloride, or acetone or benzene.

The surface of written text can be cleaned with trichloroethene which can be applied with a cotton swab along

PRESERVATION OF DOCUMENTS

the fibre length of the leaves. The surface written text can be deacidified with ammonia (1:10) and the leaves left for 12 hours. Sritala palm leaf involves the use of carbon ink. Some carbon ink writing have a tendency to smudge. As a result of handling or for the other reasons styles inscriptions may be rubbed off and should be reinked to make them legible to avoid such problems, writing on palm leaves are protected with a 5% solution of cellulose acetate in acetone or with a 5-10% solution of bedacryl (metha methyacrylate) in benzene acetone. Foxing can be removed by using alcoholic bleaching solution which is prepared as follows :

10 gms. Chloramen 'T' + 25 ml. water + little heat, after 15 minutes this solution + 500 ml. methyl alcohol is to be added. After removing the stains the treated portion of the leaves should be washed with 50% methyl alcohol in order to remove the traces of chloramin 'T'.

REINKING

It is not possible to revive writing of sritala leaves. The Tala palm which becomes dry and brittle due to loss of natural oil can be made flexible by introducing the essential oils such as camphor oil or citronella oil in the leaves with a mixture of alcohol (3:2) with a cotton swab and repeat until the flexibility comes back.

To make the text distinct, spraying of graphite powder or lamp black by means of cotton swab, and the engraved incisions are filled with excess graphite or lamp black which is removed with a soft cotton cloth and then cleaned with a (1:1) mixture of alcohol and glycerine. Then the treated leaves are to be kept in between the blotting paper under pressure for 10-12 hours.

PRESERVATION OF DOCUMENTS

The damaged leaves which have been broken at the edges and also those with large holes can be repaired with a plain palm leaf according to the size of the broken portion and shape. A plain palmleaf is cut with a sharp blade and that pieces can be fixed with fevicol with a painting brush at the joint. Then the treated leaf can be passed through the solution of 50% polyvinyl acetate in toluene to give more strength. It will help for fixing of ink and strengthening of the palm leaves.

REPAIRING

- i) Palm leaves repair can be done by chiffon or tissue special quality with carboxy methyl cellulose.
- ii) A palm leaf is encapsuled in between two polyester or polypropelene film which is slightly larger in size than the palm leaf. The edges of the two sheets are sealed by a double sided tape. Palm leaf can be laminated by moranco type lamination machine. This method employs the use of cellulose triacetate film coated on one side with adhesive under heat and pressure at 60°-70°C for 2 minutes. they can be laminated with the polythene film (.03-.035 mm thickness) at 120°C by ironing.

REPAIR AND RESTORATION OF BIRCH BARK

The birch bark should be cleaned with fine camel's hair brush as far as possible. Then the bark is cleaned with glycerine and water where ink is insoluble in water, or with Lissapol-N and alcohol when the ink is water soluble. Small adhesive portions can be separated with help of sharp knife, otherwise the bark MSS are separated in a hot solution of paraffin oil, which also washes away much dirt as it separates the sheets. After cleaning, the bark MSS should be dried on a glass plate. For fixing the layers and also strengthening the MSS the

PRESERVATION OF DOCUMENTS

C.M.C. paste should be applied with a fine brush in between the layers and on the MSS. After drying, the broken portion can be joined with the help of C.M.C. paste and Japanese tissue paper by applying on both the sides of the MSS.

For removing the grease and to get the flexibility, essential oil viz. citronella oil can be used on both the sides of the MSS. Then it is kept under pressure for 24 hours.

EFFECT OF WATER-DAMAGED DOCUMENT

- i) Generally 7 to 10% RH remain in paper at normal temperature & pressure, but tensile and folding strength decreases gradually when the ordinary paper is well soaked in water.
- ii) The Loading and sizing material or the wet paper dissolved in water. Glue and pastes smear, create smudges and lead to locking of books and documents or bundles.

Iron is inherent constituent of the paper when it gets wet. Iron hydroxide produces which causes foxing. The starch paste or animal glues are present, which act as nutritive substance for fungi.

The books are required to rescue from the rain water through trolleys. The sizing material becomes softened by water, as a result, pages stick one another and consequently it becomes solid mass. Wet pages should be carefully lifted from one another and placed individually between white blotters and pressed, when the papers are fairly dry, they are ironed to complete the process. Hot air was blown over the documents in a wide range as there was large number of books. Inferior quality of paper got damaged heavily than that of rag and cotton quality fibre. Partly water soaked document was dried

PRESERVATION OF DOCUMENTS

up by interleaving white blotters. Treatment is given first to the books which are made of art paper, gets stick together and become impossible to separate without damage.

In the first instance, 50°C hot water is used for opening the jammed document or treated with hot steam.

There are two types of adhesives :

- a) Starch based adhesives
- b) Protein based adhesives

Type of enzymes selected depending upon above two categories of adhesives.

Starch based adhesives

Starch consists of chemical mixture of two components, amylose and amylopectin, both of which are polymers of glucose (a simple sugar). The proportion vary according to the natural source of the starch, but typically 25% amylose and 75% amylopectin are present. To effect maximum degradation of the starch for a minimum of enzyme treatment, it is necessary to cut the amylose and amylopectin molecules into short lengths (dextrine). This can most readily be done using amylose, which will completely degrade amylose into small dextine and partially affect amylopectin, the sum effect being the cause of sufficient degradation to break up the adhesive mass into microscopic particles which can easily be removed. The optimum temperature and p^H for the action of α amylose are 37°C - 39°C and 6.95. Under these conditions, it is possible to use much lower concentration of the enzyme. A concentration of 0.5% W/V is normally employed, this being considered the upper limit of what is required.

The excess enzyme is removed by washing in two changes of ordinary tap water at room temperature (20°C) followed by a

PRESERVATION OF DOCUMENTS

hot rinse in tap water at 50°C.

Protein based Adhesives

Animal glues composed largely of protein may be added as pastes. Ordinary flour paste contains some protein which may account for some of its adhesive properties.

Trypsin solution is used at the optimum temperature about 40°C and pⁿ. 7.4. A concentration of 0.5% W/V is normally employed, as optimum level. It will break down any bond of protein adhesive. A non-specific enzyme "protease" at a concentration of 0.05 W/V solution at 40°C and pⁿ 7.45. The treatment is identical with the α amylase. Protease would otherwise attack the α amylase which is of course itself a protein. The α amylase is used first as the residual enzyme can then be destroyed by the protease, thus eliminating one washing step.

Where coloured inks or paintings are encountered, extreme caution should prevail. Ink should fix with cellulose acetate in acetone or polyacryl acetate in toluene before enzyme treatment. Parchment & Vellum whose fibres are composed of protein, could not be treated with protease.

This method is adopted in the case where ink is saved in water.

- a) Store the bottles of enzyme in polythene bags with some silica gel in the freezer part of the refrigerator.
- b) Make a stock solution of buffer. Note buffer solutions have a limited shelf life and should be stored in the refrigerator.
- c) Decide if starch or protein or both are to be decomposed.

PRESERVATION OF DOCUMENTS

- d) Warm 900 ml, purified water to 40°C.
- e) Add 100ml buffer solution.
- f) Place dish in hot water sink, add warmed dilute buffer.
- g) Leave thermometer in dish, temperature should be 37°C (enzyme deteriorate over 40°C and are very ineffective in the cold).
- h) If starch is to be removed, add 1g. (1 small level tea spoon) α amylase to buffer, stir in gently.
- i) Place document between wet strength paper and immerse in enzyme.
- j) Stir the dish occasionally and keep an eye on the temperature.
- k) It takes to reduce the starch & anything from 30 min to 4 hrs. Test by placing blotting paper against the document and then dipping it in dilute iodine solution, a purple colour indicates that starch is present.
- l) If protein is to be removed, take fresh warm dilute buffer solution as before and add 0.1g of protease use in the same way at 37°C.
- m) When all traces of paste and glue have gone, rinse, deacidify & resize.

PRESERVATION OF DOCUMENTS

STRENGTHENING OF DOCUMENTS (MASS CONSERVATION)

Newsprints are generally manufactured from Mechanical wood pulp and semi chemical wood pulp which are ephemeral in nature. The sources of newsprints contained high percent impurities such as lignin, tanin, pectin, as a result it deteriorate very fast. The longevity of the newspaper is not more than twenty five years. In depository Libraries like National Library, the newspaper collection is from 18th century onwards. Therefore, news paper has a major vital activity in the field of the preservation. News paper preservation comprises of two aspects i.e. physical preservation and microfilming. Very brittle newspaper can be conserved by microfilming where physical preservation fails to fulfil the purpose.

Physical state of newspaper holding

National Library, Calcutta had the first Indian newspaper 'Hickys' Bengal Gazette 1780. Above 200 years old newspaper gets brittle and brown edge which contains acidity (p^H is 4) and middle portion of the paper is not so brown (p^H is 4.5). This is the clear evidence how the air pollution penetrates the bound volume of the newspaper. These pollutions like SO_2 ($81/\mu g/m^3$), NO_2 ($65/\mu g/m^3$), H_2S ($3/\mu g/m^3$) are coming from the nearest zone. The test results shows that the oldest newspaper having the highest acidity and folding and tensile strength gradually gets lower and lower.

Manufacture of Newsprints

Newsprints are combination of 80% Mechanical wood pulp and 20% semichemical wood pulp. Mechanical wood pulp contains 22% lignin and Semi-chemical wood pulp contains 10% lignin.

PRESERVATION OF DOCUMENTS

Mechanical wood pulp is prepared from hard wood which is cut into small pieces. Chipped and ground against a large grinding stone. The yield of pulp is high by this process but pulp is of low purity and contains 17-26% lignin which damage fibre.

Semi Chemical Wood Pulp

Hard wood (22% lignin) is cut into small pieces and chipped. The wood pulp is taken in a metallic digester where 6% to 8% Caustic Soda is added and boiled at 60 to 100 lbs. steam pressure. Then only 10% lignin remain out of 22% of lignin in hard wood and some other impurities are also removed.

In the year 1965, Indian Government has set up a newsprint factory named Nepa Paper Mill. It is situated at Nepanagar in Madhya Pradesh. At present Indian Government imports about 60% newsprint from foreign countries.

The ingredients of the newspaper are cellulose, hemi cellulose and lignin in large quantities (22%) and resins, volatile oil, tannins, natural dyes, hydrocarbons, pectins, mucilages, gums, starches, protein and organic acid in smaller quantities.

High percent of lignin is the main factor of newspaper deterioration and the separation of lignin is not possible without chemical and mechanical means. Delignification from hard wood pulp is a challenge to the paper industries, perhaps one should take a first look to the process involved in the production of wood pulp paper for clues in developing necessary treatment.

Of all the reactions which lignin undergoes, sulfonation, oxidation, and halogenation are of particular importance to the pulp and paper because of their relationship to the pulping and bleaching processes. In sulfite pulping, a water-dispersible

PRESERVATION OF DOCUMENTS

lignosulfuric acid is produced. In the soda process, alkali-soluble alkali lignin is produced by reaction of alkali with the phenolic hydroxyl groups. In the sulfate process, sulfur enters the lignin molecule to form alkali-soluble thioglignin. If wood is cooked with nitric acid, rest of the lignin is converted into water-soluble products and part is nitrate. If the process is not carried too far, an alkali-soluble "nitrolignin" is produced.

Lignin is very, susceptible to oxidation in two ways
(I) Chemical Oxidation in presence of nascent oxygen
(II) Biological Oxidation in presence of Biological Organism.
Under mild oxidizing conditions, lignin is broken down into aromatic acids like benzoic acid and becomes yellow. Under more drastic conditions lignin is oxidized to acids such as formic, acetic, oxalic and succinic. Under mild condition which prevail in (newspaper) commercial bleaching processes, lignin is converted into products which are soluble in either water or alkali. In the soda process, alkali-soluble, alkali lignin is produced by reaction of alkali with the phenolic hydroxyl group. In order to control lignin degradation necessary step should be taken to stop or reduce the above mentioned two oxidation processes by (a) Maintaining low temperature (b) Maintaining low humidity (c) Maintaining a situation so that nascent oxygen cannot be produced.

In the chlorination process, where straight chlorine is used, both substitution and addition of chlorine in the lignin molecule take place. Lignin is very readily chlorinated, and it is possible to obtain chlorinated products containing up to 25 to 38% chlorine when isolated lignin is used, although this high degree of chlorination is not obtained in commercial bleaching. These chlorinated lignins are soluble in alkali and have a lower methoxyl content than the original lignin. If chlorination is carried beyond about 35%, appreciable degradation of the lignin is obtained.

PRESERVATION OF DOCUMENTS

Author made an experiment with the three sizing materials such as gelatin powder, sodium salt of carboxy methyl cellulose, cellulose acetate powder. These sizing materials are used as impregnating reagents polymer solution and 5% calcium carbonate solution is treated for deacidification. Sizing of the Newspaper is done on the glass top or wax paper.

One set of 1% and 2% gelatine solution, sodium salt of carboxy methyl cellulose solution and cellulose acetate powder in acetone are prepared. These solutions are applied quickly after preparation to the individual newspaper leaves using a flat brush roughly 15 centimeters wide.

It is observed that gelatine solution gives more stickiness on the newspaper. 2% sodium salt of carboxy methyl cellulose should have high longevity of newspaper but it has a little bit stickiness. 2% cellulose acetate powder with acetone gives a homogeneous solution fixed the newspaper as well as book which increases more longevity.

Impregnation in a Vacuum and Freeze Drying

Lyophilization : Mass Conservation

Professor Otto waechtee and others of the National Library, Austria, Conservation Department made an experiment with using the familiar methyl cellulose in the impregnation process. The impregnation process improved by several means for its necessity. It is also a mass conservation methods as well as DEZ Process which has been developed in U.K. and U.S.A. Viscous Cellulose Solution do not penetrate the newspaper block well. Newsprint acts like a filter paper, that is, it lets the water through and holds back the cellulose.

They used low viscosity (more easily penetrating) Cellulose types Methyl Cellulose 14 or Methyl Cellulose 40; they are

PRESERVATION OF DOCUMENTS

scarcely weaker in their strengthening effects for wood pulp printing paper than the high viscosity methyl cellulose 400. In the opinion of paper chemists this can be explained by the fact that these celluloses, which are weaker in their binding powder but more flexible, can better penetrate the paper structure and better envelop the fibres. Therefore, after the brittle paper is dried out, they can provide almost good support and high viscosity celluloses with more binding but less penetrating power. In the case of newsprint, low viscosity celluloses are weaker in their sizing effects, but they nevertheless cause about a 150% increase in the strength of the fibre structure both in height and width.

For "normal brittle" newsprint (the ones which at the "Deacidification Talks" of the Library of Congress in June, 1985 were assigned the fold endurance count 1-50 categorized as weak to moderate), cellulose of various viscosity are sufficient. For the category "brittle", with the fold endurance count of 1, they are too weak. In this case, softener-free polyvinylacetate was tested to supplement the cellulose (Planatol PV/H9, Walpol SA 500 and Walpol VA 413); these watery artificial resin dispersions combine optimally with the cellulose. Even the supplemental magnesium and calcium buffers create no difficulties with regard to penetration or the subsequent freeze drying.

Further experiments were conducted to improve the penetrating powers of these solutions. They attempted to make the text blocks more receptive through the insertion of wire bands after each section by spreading open the text block with the help of perforated aluminium sheets. This was successful with small format text blocks (up to the size of a telephone book) but beyond that there were problems. It turned out, however, that it was not necessary to spread open

PRESERVATION OF DOCUMENTS

the text blocks if the newspaper volume was not thicker than 4 cm. Up to this size the strengthening solution can penetrate any format in a vacuum. Loose newspaper leaves are now treated in 4 cm. thick bundles. Thicker newspaper volumes are broken into 3-4 cm thick blocks after the old boards have been removed (normal volumes are therefore usually divided in half) in such a way that the remainder of the old binding (only where stitching should be cut away by machine) stays on the text block for the rest of the process. It provided support and prevents movement of the sheets in the text block.

The Theory of Freeze Drying

Dehydration:— The separation of a substance that is to be dried from its water content already begins while ice is forming during the freezing process. During the drying process however, a greater number of water molecules leave the dried substance.

During the freezing process, low temperatures should be attained as quickly as possible, thereby reducing the tendency towards crystal formation. When a liquid hardens into a solid body, crystallization can occur, i.e. the molecules are incorporated into a crystal lattice thus bringing order to their previous amorphous state. If the temperature however, is very low, the kinetic energy available during hardening is insufficient to bring them to their places in the crystal lattice. The molecule structure hardens in its amorphous state and maintains this after drying, exactly retaining its original characteristics. This is true especially for biological solutions.

The formation of small crystals can, however, hardly be avoided. Luyet and Gehnio (IFLA, 1986) have demonstrated that the temperature drop must come to at least some 100°C per second in order to ensure that freezing takes place in an

PRESERVATION OF DOCUMENTS

exclusively amorphous state. But small crystals do not cause great damage. At slower freezing rates, on the other hand, larger crystals form, since the size of the crystals is inversely proportional to the denseness of the crystal population and the speed of freezing. The creation of small crystals produces some benefits; on drying they leave behind so-called vacules, small hollow spaces through which the remaining water molecules can somewhat more readily pass to the surface of the item being frozen. For rapid deep freezing, the freezing temperature should come to 40°C in order to guarantee that the text block freezes through. Depending on the eutectic point of the solution being used, the temperature can then be raised up to just under the freezing point, where the vapour pressure of ice is at its highest and therefore the drying rate is fastest. The eutectic point during freezing is -30°C for water soluble MC; with a polyvinylacetate additive, it is -24°C .

The layer thickness of the text blocks creates a problem, especially because of the insulating effect of the paper. The large water content also plays a role. During impregnation the weight is multiplied. The condensor and pumps used in the equipment must be very powerful. As the vapor pressure drops, the drying process is retarded. Above all, in the final stage of drying a particular problem arises since increased heat of sublimation must be supplied to already dried insulating layers of paper. For especially extensive newspaper volumes, one could accelerate the procedure by using the laboratory technique of freezing with dry ice.

DESCRIPTION OF THE IMPREGNATION PROCESS

The block or bundle of newspaper leaves 3-4 cm. high is put into a metal tub that is perforated on the lower edge (to allow the excess solution to run off after impregnation) and has two handles. The height of the tub is 6.5 cm. The drawers in the

PRESERVATION OF DOCUMENTS

freeze dryer have a difference of 7 cm. The metal tub is placed in a plastic tub which is slightly larger and 10 cm. high. The newspaper block with the tubs are put into the vacuum machine (Fig. 1). Complete vacuum as possible as is created so that the air is substantially withdrawn from the fiber interstices. With the use of exterior controls, the text block is flooded with the strengthening solution. After about two hours, the text block is completely saturated and air is once more let in, simultaneously forcing the solution deep into the fiber interstices. (If it occurs that the impregnation process actually allows for more through saturation of the border areas than of the central portion, it is not disadvantageous, since the outer portion of the text blocks have been subjected to more environmental damage and require more intensive restoration.)

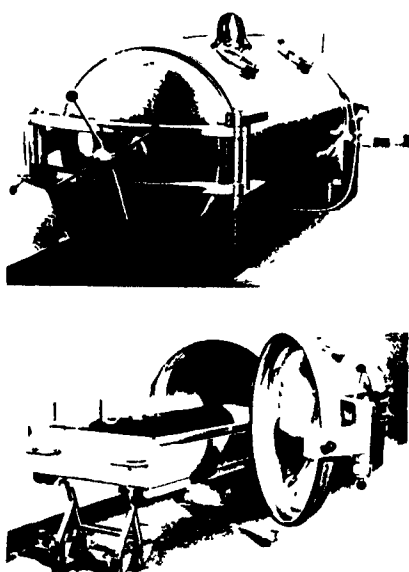


Figure - I
Vacuum Chamber for Impregnation of Newspaper Blocks

PRESERVATION OF DOCUMENTS

The following should also be taken into consideration during the impregnation process. To impregnate a text block 3-4 cm high, one requires about 18 liters of liquid for a mid-size format newspaper; 2-3 liters are pressed out by hand after the impregnation; this is the solution which can no longer be absorbed by the leaves. During impregnation, the text block swells to about twice its height. After the manual liquid removal, it drops back a quarter (4 cm to 8 cm to 6 cm).

(One aid in the impregnaion process must still be mentioned). When the regenerating solution is poured into the tub, the text block always floats to the top. During this phase it must be kept down by the use of clamps.

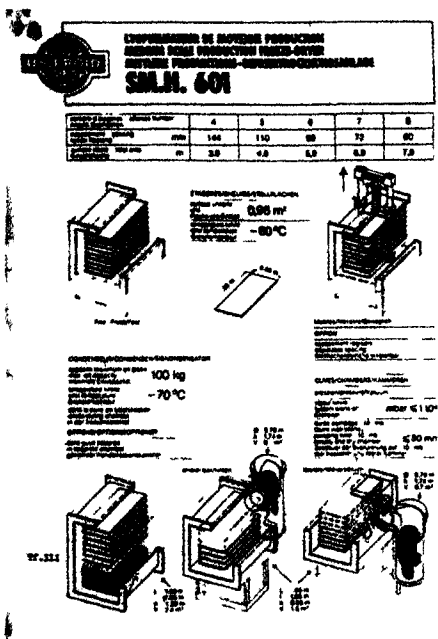
Their part must be sufficiently flexible not to inhibit the swelling of the text block. For this purpose 3 cm-wide strips of sheet aluminium is used. They are soft and can easily be bent around the text block and the tub.

When the text block swells, they yield but still hold it down in the tub. After impregnation and the subsequent pressing out of the solution, the inner tub is placed over a sink to drain.

During subsequent steps the text block remains in the metal tub. It next comes into the quick freeze chamber, where it is to be turned into an ice block as quickly as possible. At first temperatures of from -30° to -40°C are necessary in order to avoid the formation of large ice crystals. Five hours are required to deep freeze the text block. After they are frozen through, the ice blocks go into the freeze dry chamber (FIGURE II). Here the work is carried out in a vacuum. Through a prescribed sequence of freezing and heating, the "frozen product" is now treated in such a way that it is held just under the freezing point (it can not be allowed to thaw) but the water evaporates so that drying can proceed. The

PRESERVATION OF DOCUMENTS

pressure is regulated to correspond to half the pressure of the water vapor at the sublimation temperature. In this case, since water is the chief component of the solution, a value between 1 and 4 ml was required. It is advisable to arrive at the final temperature of the shelves in stages. At the beginning +35°C is sufficient; this is finally raised to +70°C. It is necessary to find the heat of sublimation which effects rapid drying without allowing the frozen product to thaw out. At the beginning only this apparatus which could be regulated slightly; the frozen product remained for the longest period at -30°C and freeze drying therefore took about one month. With the freeze drying equipment, two days are required for dry out the ice block. It was this reduction of the drying period which made this procedure possible and economical.



Freeze dryer

PRESERVATION OF DOCUMENTS

Upon completion of impregnation and drying, decisions must be made on the future binding of the newspapers.

- 1) In the best case, where the block is only 3 cm (or even 4 cm) thick and the binding has not fallen apart, it is often sufficient to put the text block back into its old boards after it has been compressed.
- 2) If the volume had to be split and this did not cause the binding to fall apart, it is possible, as with adhesive bindings, to put the sections back together and to hang them in the old boards.
- 3) If the old binding has loosened or fallen apart during impregnation and freezing, the volume must be cut afresh at the spine and then supplied with an adhesive binding.
- 4) Unbound bundles of newspapers or wire-stitched volumes cut at the spine before impregnation must be adhesive-bound. A new set of boards must be made.

The impregnation procedure described above was developed primarily for newspapers and newspaper volumes. Someday it will certainly be possible to apply this method to books and periodical volumes, but the conditions must be somewhat modified. Newsprint, because of its naturally relatively high absorptive capacity can be best treated by using this system.

PRESERVATION OF DOCUMENTS

DISASTER CONTROL MEASURE

In recent years libraries have become increasingly aware of the need for a "disaster plan" in order to cope with damage to the library building and collections resulting from a sudden, unexpected event such as a fire or flood.

Fire

The main causes of fire in libraries are smoking, electrical faults and arson.

As books are compact objects, they tend to burn fairly slowly. In many instances the covers of a book will protect the text block against burning so that the paper is charred only at the edges. In a major fire shelving can easily collapse decanting books on to the floor where the damage is likely to be more extensive. Smoke and soot will mark or stain the area generally including books which have otherwise not been affected by the fire.

However, the main hazard after a fire is water-damage caused by the use of fire-hoses-here the problems are the same as those caused by flooding.

Flood

The most common causes of flooding in libraries are blocked drains, a burst pipe or leaking roof.

Flood water leaves dirty marks on books, causing dyes to run and loosening adhesives. Generally speaking, pre-1850, books will absorb water to a greater degree than more recent books which are often printed on less durable papers. All books will swell when wet; the action of swelling can dislodge books from the shelves, while books which are already tightly

PRESERVATION OF DOCUMENTS

shelved can be extremely difficult to remove when swollen. Books containing glossy coated papers, normally used for illustrations, will "block together" when wet.

After a fire or flood mould will soon begin to form in the damp conditions. The spores can spread quickly to other areas of the library which may not have been damaged by the fire.

Further hazards can arise from local weather conditions and from structural faults in the building.

The fungus grows in the adjacent area of the Lavatories due to high humidity playing round the Clock. The Lavatory should be constructed outside the stack area.

THE PLANNING PROCESS

A disaster plan should be developed to include preventive measures and procedures for recovery after an incident. It is recommended that a planning officer should be appointed to co-ordinate the project. Once the plan has been drawn up, it will be necessary to train library staff in recovery procedures. Responsibility for dealing with an incident might be shared among senior staff of "Disaster Control Officers".

The disaster plan should take account of the condition of the building, noting potential hazards and trouble spots. Here the planning officer will work in liaison with the accommodation or buildings officer. Plans of the building will be available in most libraries and at least an outline should be included in the disaster plan.

Careful maintenance of the building will help to reduce risks. The local fire brigade will advise on fire safety and any problems arising from the structure of the building. Automatic alarm devices such as smoke alarms and water detectors

PRESERVATION OF DOCUMENTS

should be considered, particularly as a means of protection during closed hours. Even if a caretaker is on site it is difficult for one person to patrol an entire building. The disaster plan should include a list of staff who can be contacted outside normal working hours.

The planning officer should consult with other library staff in order to identify items that might take priority during a salvage operation. These might include special collections and rare or vulnerable items. It is important to ensure that the library is adequately insured against damage to the building and the collections and also to cover the cost of recovery and any subsequent conservation work.

The disaster plan should be written up in the form of a manual which can be revised as and when necessary.

Salvage equipment

It is advisable to keep some equipment in book stack areas in special boxes or on trolleys, with a back-up supply stored in an easily accessible location.

Equipment for immediate use should include : white blotting paper for interleaving wet books, linen bandages for supporting weak bindings and a supply of freezer bags, J. Cloths and sponges, and some pre-cut lengths of polythene sheeting to protect undamaged books. Pens and a notebook should be available for recording damaged items.

Protective clothing of trained staff will be required and should include work aprons, rubber household gloves, wellington boots, dust masks, safety goggles and helmets.

The back-up store should include maps, buckets and sawdust (to absorb water), rolls of polythene sheeting and an

PRESERVATION OF DOCUMENTS

emergency pump or vacuum cleaner. Cold air fans, which may be available in offices, will be required for drying wet books.

Stabilising the environment

After a major fire or flood, the environment must be stabilized and controlled before and during the removal of salvage items. A reading of relative humidity should be taken using a hygrometer or small polymeter. If the RH is above 60%, a dehumidifier can be used to reduce it to between 50 and 60%.

The Disaster Control Officer will need to liaise with the professional officer on necessary to stabilise the environment. After a serious incident, it is often necessary to turn off all the power in the area (the location of the power plant and all supply points should be included in the disaster plan). Doors and windows can be opened (if it is not raining) to help reduce relative humidity. Emergency lighting may be required and torches and battery lamps should be available.

Polythene sheeting can be hung over undamaged materials while books which are immersed in water can be left there until the area has been made safe for salvage work.

Salvage Procedures

Damaged books must be removed to clean, dry area where they can be sorted and packed either for immediate treatment or for freezing. A reading room or office would be suitable, and tables are covered with polythene sheeting while salvage work is in progress.

Do not open wet books or attempt to close them if swollen. For the time being leave them in the condition in which they are found. It is advisable not to clean books or wash away

PRESERVATION OF DOCUMENTS

dirt at this stage.

Remove books first from the floor and then from the shelves, working downwards to avoid any danger of collapse. The damaged books can then be shifted to the sorting area.

Sorting is best approached by segregating the damaged books into broad categories. Historic books or items of special interest can be given priority for immediate treatment.

Slightly or partly wet books can be interleaved with white blotting paper to absorb some of the water and then sent for air drying.

If there is a large number, the worse affected items can be sent for freezing and put into cold storage for treatment at a later date. Most modern book materials may withstand freezing but sensitive materials such as vellum should be left for the attention of a Conservator.

Any books which have developed mould should be frozen as soon as possible in order to prevent the mould spores spreading to other books. Coated papers also require immediate treatment if there is to be any chance of saving them.

Badly damaged items that can easily be replaced might be written off against insurance. It is advisable to record each damaged book and estimate damage and loss for insurance purposes.

Books requiring treatment should be packed into crates for transportation. Packing those with the spine down will avert any danger of the text block sagging from the binding. Large heavy books are best laid flat.

Books intended for freezing should first be wrapped from head

PRESERVATION OF DOCUMENTS

to tail with a linen bandage to prevent further distortion.

Those should then be put into individual polythene bags or at least separated by bags (this will prevent books sticking together when frozen). If there is time, a label can be attached with the book's shelfmark or a brief title.

Damaged microfilm should be kept in clean water and sent to a laboratory for treatment. A bucket with a lid makes a suitable container.

Wet microfiche should be laid with the emulsion side uppermost on white blotting paper. If done quickly, this will help to prevent fiche sticking together.

Book crates should not be overloaded as the books are generally much heavier when wet.

Once the damaged items have been removed, the disaster area will need to be thoroughly cleaned and aired. Several weeks or months may pass before all excess moisture is dried out.

Air drying wet books

Damp or partly wet books can be dried by means of cold air fans. The books should be kept upright with their pages spread out around fans placed at intervals of 4 or 5 feet.

The drying process can be speeded up by constructing a "wind tunnel" from plastic panels of a kind normally used to make a garden cloche. The panels must be secured by angle irons. Even by this method air drying can take up to week.

If mould has been discovered, a salvage consultant or conservator should be asked to advise how to disinfect the area.

PRESERVATION OF DOCUMENTS

All but the most simple repairs to the damaged books should be left to a trained Conservator.

Vacuum and freeze drying

Books which have been put into cold storage can be vacuum or freeze dried at a later date. In this process the damaged books are placed in a vacuum chamber where the water is extracted in vapour form.

PRESERVATION OF DOCUMENTS

SALVAGE OF WATER-DAMAGED DOCUMENTS

Weather is the critical factor in determining what course of action to be taken after any flood or fire in which museum, archival, or library materials are damaged. When it is hot and humid, salvage must be initiated with a minimum of delay to prevent or control the growth of mould. When the weather is cold, more time can be taken to plan salvage operations and experiment with various drying procedures.

Stabilization by Freezing

The most generally accepted and proven method of stabilizing water-damaged library and archival materials is by freezing and storing at low temperature (-20°F). This time in which to plan and organize a controlled, carefully coordinated drying operation. Freezing gives the restorer time to dry individual items and collections in the knowledge that they will be in the same condition upon thawing as before they were frozen. Cold storage provides accessible and inexpensive space in which large quantities of books can be stabilized in the condition in which they were found, preventing further deterioration by water and mould while awaiting treatment.

Freezing is not a drying method, nor will it kill mould spores, but it is highly effective in controlling mould growth by inducing the dormant state in the spores. The drying method chosen at a later date must be such that mould is kept dormant so that subsequent sterilization can achieve maximum benefit.

Stabilization by freezing also provides important advantages when it is not possible to assess immediately the value of the damaged materials or to determine which items can or cannot be replaced. In other words, such stabilization gives time in

PRESERVATION OF DOCUMENTS

which to estimate recovery costs, to prepare adequate environmental storage conditions, and to restore the buildings affected. In some cases, it may be necessary to restore or rebuild the original facilities, a process which can require a long time.

Preparation for Freezing

Before freezing, it is preferable to wash away accumulated mud and filth, but this is rarely possible because of lack of time and the quantity of material to be handled. Washing should never be attempted by untrained persons as this may cause further damage, nor should time be taken for this purpose if so little help is available that any significant delay in freezing the bulk of the materials would result.

The washing of materials containing water-soluble components, such as inks, watercolour, tempera, dyes used in certain maps, and the like, should not be attempted in any circumstances. Experience has shown that such materials, as well as those that are fragile or delicate, can be seriously or irreparably damaged by untrained workers attempting to clean and restore onsite. Such materials need expert attention and hours of careful work if damage is to be kept to a minimum. The period of emergency action and "first-aid" is no time for the careful work required to restore materials to near-original state.

The general condition of the damaged materials will determine how much time can be spent in preparation for freezing. At the least, bound volumes should be wrapped in freezer paper, wax paper, or silicon paper to prevent their sticking together during the freezing process. Groups of sheet materials such as manuscripts, records, unframed prints and drawings, and the like should also be wrapped, the packages not to exceed

PRESERVATION OF DOCUMENTS

about two inches in thickness. Each package should be marked to indicate type of material, its previous location, and its priority. However, if it is known that the damaged materials will be vacuum or freeze dried after freezing, the wrapping step may be avoided by substituting milk cartons as a means of limiting the materials to be frozen to small groups which are more readily handled.

When only a few items are involved, freezing can be accomplished in a home freezer. Naturally, if the collection number is hundreds of thousands of volumes, larger facilities will be required. The temperature for freezing should be at least -20°F. Lower temperatures will do no damage. Rapid freezing produces the smallest possible ice crystals and is desirable for this reason, especially if the material is to be freeze dried at a later stage.

Containers and Methods of Packing for Freezing

Interlocking plastic milk crates make excellent containers for packing wet materials. These measures are easily lifted, and offer the most efficient unit for freeze or vacuum drying, if one or the other process is to be used at a later date. They will not crush and can be stacked on pallets to a level just below the roof of a refrigerated truck. They also provide compact and safe storage in freezer plant.

Strong cardboard boxes (approximately two cubic feet), similar in size to beer cases or boxes used by libraries for sending books to library binders. However, wet books will make the boxes damp and abnormally heavy, cardboard boxes cannot be stacked as high as milk crates without both boxes and their contents being crushed.

Materials should not be packed tightly in either type of container. Faster freezing and subsequent drying will be

PRESERVATION OF DOCUMENTS

accomplished if the cartoons are packed approximately three-quarters full.

Rehabilitation after Freezing and Drying

If maximum benefits are to be gained from stabilization by freezing, every effort should be made, first, to identify and assess the value, condition, and total numbers and types of materials damaged, and second, to draw up comprehensive lists of those materials which can be replaced and those which should be reclaimed and restored. Replacement is nearly always cheaper than restoration.

Volumes to be reclaimed will need to be evaluated in terms of the amount of restoration needed and probable costs. The best time to make such judgement is after the volumes have been dried and before they are returned to the library.

If the water-damaged material was infested by mould at the time of freezing, it should be sterilized. In vacuum drying, sterilization with ethylene oxide mixed with either CO₂ or Freon is easily accomplished at the end of the drying process, while the materials are still in the vacuum chamber. The results are well worth the small additional charge.

Although the sterilized materials are safe until environmental conditions may again be favourable for mould growth, it is suggested that sterilization be followed by fogging the chamber with a solution of 12 percent thymol in trichloroethylene. This treatment acts as a temporary "fungicidal buffer" and confers a high degree of resistance to further attack, even when conditions are favourable for mould growth. This treatment also provides an additional safeguard in case sterilization was not thoroughly done.

PRESERVATION OF DOCUMENTS

It should be remembered that sterilized material can be reinfected by mould, especially if placed in an environment characterized by poor ventilation and high humidity. For this reason it is imperative to avoid mixing sterilized and unsterilized material. Under no circumstances, newly dried materials should be packed in boxes and left without attention for more than a few days.

Ideally, all water-damaged materials should be sterilized where this is not possible, the following precautions should be observed :

1. All returned, dried materials should be placed on open shelving in a ventilated and air-condition "rehabilitation" area, well separated from the main collections. Such a rehabilitation area makes it easier to assess the condition of the dried materials, as well as to identify those that can be replaced and those must be restored and to plan for restoration. A carefully organized, random inspection for mould-infected materials can be conducted daily by personnel trained to carry out this important task in the rehabilitation process. Whether materials have or have not been sterilized during the drying process, it is necessary to monitor their behaviour as a check against the effectiveness of sterilization and to identify any potential for mould growth before the return of these materials to the main collection.

We are concerned here with monitoring the dried volumes while they are in the rehabilitation area. It is good practice, however, to make a random selection of several volumes from such groups and to check them for possible development of mould following their return to the main stacks. This monitoring should be continued at regular intervals for at least a year after reshelving.

PRESERVATION OF DOCUMENTS

The rehabilitation area should be able to maintain a relative humidity of 35 to 45 percent and a temperature not exceeding 65°F. Both humidity and temperature controls must be adjustable.

It is desirable to maintain the collection in the rehabilitation area under these conditions for a period of at least six months, if at all possible. At this time, temperature and humidity in the rehabilitation area can be gradually changed to duplicate conditions in the stack area to which they are to be returned. At the end of this time, if no mould growth has occurred, the volumes can be returned to the main stacks and monitored as indicated above. It is highly desirable but usually not practical to leave volumes in the rehabilitation area for an added six months as a check against later mould growth.

2. No materials should be returned to the main library shelves without very careful inspection by a qualified conservator, and preferably not before all necessary restoration is complete.

RAPID PROCEDURES FOR SALVAGE

These procedures apply whether or not freezing is to follow.

1. In winter, turn off all heat in the building. In summer, reduce the temperature as much as possible through air-conditioning, if available.
2. Create maximum air flow through all affected areas by opening doors and windows. If electrical facilities are operational, use as many fans as can be acquired to create a current of air so directed as to expel the humid air from the building. If dehumidifiers are available they

PRESERVATION OF DOCUMENTS

may be used with fans for small enclosed areas. The object is to avoid pockets of stagnant, moist air.

3. If house electricity is not available, hire portable generators to provide electricity for lights, fans, dehumidifiers, and other electrical services. For safety purposes, all electrical lines should be waterproofed and grounded.
4. Do not permit anyone to open wet books; to separate single sheets; to remove covers when materials are water-soaked; or to disturb wet file boxes, prints, drawings, and photographs. Such handling can result in extensive and often irreparable damage to materials that otherwise might be salvaged. Reducing the cost of future restoration must be one of the top priorities of the salvage operation.
5. Organize a disaster team and prepare a comprehensive plan of action, as well as plans for different contingencies.
6. Do not attempt to remove materials from the area until an overall plan with a schedule of priorities has been established and all personnel thoroughly briefed.
7. Canvas the community to locate freezing and storage space.
8. Seek the advice of specialists who can assist at the site of the disaster.

CLEANING AND DRYING WITHOUT FREEZING

Preparations for Drying : The following procedures should be attempted only by trained staff and well-supervised staff. All drying rooms should be set up well away from the affected

PRESERVATION OF DOCUMENTS

areas. They should have a controlled environment will remove moistureladen air and which can be maintained at a constant temperature. Additional heat may be supplied to these areas provided the air is well circulated at all times. Pockets of stagnant air should not be permitted, and cleanliness should be maintained by prompt removal of wet debris as soon as collected. Plastic bags designed for garbage or lawn clippings are ideal for this purpose. One or more persons should be assigned the task of keeping work areas and floors and clean as possible and free of wet material to reduce moistures and to avoid loss or manage to manuscript leaves and parts of documents mixed in the debris.

Wet materials should be separated into small units, either by loose packaging or individual wrappings, to permit a free flow of air around them and to prevent the crushing which occurs when materials collect in large piles.

Cleaning : The mud deposits on books which will not be further damaged by water may be washed off in clean running water. Closed books should be held, one at a time, under water and the mud removed with a sponge used with a gentle, dabbing action. Similar washing should not be attempted with opened volumes, manuscripts, art on paper, or photographs.

Rubbing and brushing should be avoided, and no effort should be made to remove oil stains at this stage. Anything which is hard to remove is better left until after drying, even techniques for removal can be worked out during the restoration stage.

Preparing Thymol-Impregnated Sheets for Interleaving : Thymol impregnated sheets to be used as mould inhibitors will be needed in large quantities for the next steps in the drying

PRESERVATION OF DOCUMENTS

process. To prepare these, cut unprinted newsprint stock into sheets of graduated size according to the sizes of the books to be treated. A few standard sizes such as 4 by 6 inches, 5 by 7 inches, 8 by 10 and 12 inches should be adequate. Dip each sheet in a 10 to 15 percent solution of thymol crystals in ethanol, acetone, industrial denatured alcohol, or trichlorethane (1 pound per gallon of solvent). Because the vapors of these solutions are toxic and flammable, this operation must be performed outdoors. Rubber gloves, goggles, and a respirator of the type used by painters should be worked for the protection of the operator. Treated sheets should be air dried on polyethylene-covered tables. The treated sheets will dry quickly. They should then be gathered in bundles of convenient size and wrapped in aluminium foil or polyethylene and stored in a cool place until needed.

Wrapping is necessary because of the volatility of thymol. Thymol is not an effective fungicide for all types of mould, but it has been used successfully in major flood disasters. It is especially recommended because it is one of the least toxic of fungicides, can be handled with relative safety by workers, and is harmless to cellulose.

Interleaving with Thymol-Impregnated Papers : A current of air and frequent changes of the absorbent paper lying under each book will quickly dry the books to the point at which, with care, they can be opened with little risk of damage. Proceed with great caution when first attempting to open a book which has been drying. Keep the opening shallow and do not open the covers to more than a 30° angle at the first attempt. As soon as the book can be opened safely, begin interleaving with sheets of treated newsprint stock of strong paper toweling at intervals of 25 leaves (50 pages), starting from the back of the book. It is highly desirable to keep books in the

PRESERVATION OF DOCUMENTS

upright position during this first interleaving/drying stage.

Interleaving should be changed frequently, and care must be exercised not to interleave too much; otherwise, the spine will become concave and the volume distorted. If drying conditions are unfavourable because of high humidity, it may be necessary to interleave every five leaves, and to change sheets every two or three hours to dry the book with reasonable speed. Under these conditions, a distorted book is preferable to a mould book. As the book becomes dried it can be opened flat on the spine and boards and interleaved more closely. Interleaving, however, should not exceed one third the total thickness of the volume.

Some further details on the interleaving technique may be useful :

1. Used and damp interleaving sheets should not be reused unless first impregnated with thymol and dried.
2. Frequent changing of interleaving material is much more effective than allowing large number of sheets to remain in place for extended period.
3. Newsprint should not be left in books after drying is complete.
4. A good grade of paper towelling is more effective than newsprint, but the cost is significantly greater, especially for a large collection.

Technique for Separating Single Sheets : Although it is usually inadvisable to attempt the separation of single sheet, there are circumstances where freezing is inconvenient or uneconomical. Under these conditions one may wish to separate a wet mass of single items for immediate hand

PRESERVATION OF DOCUMENTS

drying. The safest method, which requires considerable skill and dexterity, takes advantage of the special properties of polyester, non woven fabric and film. Separation is carried out as follows :

1. Dampen a sheet of polyester film (3 mm thickness), and lay it on top of a wet pile of single sheets. The surface energy of water makes it possible for an experienced worker to ease away several sheets at the corner of the pile and roll or peel these back with the polyester. This material and the attached sheets should then be transferred, polyester side down, to a nearby table covered with a large polyethylene sheet.
2. Next, place another piece of polyester on top of this newer pile of wet materials. You will find that by careful, gentle manipulation, you can roll the film back with a single wet sheet attached to it. Place this, polyester side down, on a table. Place a piece of dry polyester web over the wet sheet, turn the sandwich over, remove the polyester film and lay on a second piece of dry polyester web.
3. Repeat the entire process, separating wet sheets one at a time by means of the polyester film and interleaving with dry polyester web. If desired, the materials may be safely frozen or air dried at this stage. Note that film should be used for the initial separation. Final interleaving should be done only with web.
4. If the collection is small enough to make hand drying feasible, place each sandwich (web, wet sheet, web) separately on tables or closely spaced nylon lines to dry. By the time 100 of these have been processed, the first sheet will be dried. Care should be taken that fans do not

PRESERVATION OF DOCUMENTS

blow directly on this material. Gently warm air may be used, plus good ventilation to remove excess moisture. Air conditioners or dehumidifiers may also be employed to advantage in drying.

PHOTOGRAPHIC MATERIALS

Photographic materials should not be frozen unless they are dried, since the formation of ice crystals may rupture the emulsion layer and leave marks on the film.

Monochromatic Materials:— For emergency stabilization, wet, muddy black and white negative film and prints should be sealed in polyethylene bags and placed in plastic garbage cans (not metal) under clean, cold running water. Black and white negative film and prints can be left under such conditions up to three days before the emulsion separate from the film backing.

Colour Slides and Colour Negative and Positive Film unless colour materials can be transported to a professional photographic service within 48 hours after immersion in water, coloured layers will separate, and the dyes will become weak or will be lost altogether. After this time, the best way to save a large collection is to freeze it until special arrangements can be made.

EMERGENCY PROCEDURES

1. Seek the advice from conservators in salvaging water-damaged materials as soon as possible.
2. Turn off heat and create free circulation of air.
3. Keep fans and air-conditioning on at night, except when a fungicidal fogging operation is in process, because a constant flow of air is necessary to reduce the threat of mould.

PRESERVATION OF DOCUMENTS

4. Brief each worker carefully before salvage operations begin, giving full information on the dangers of proceeding. Emphasize the seriousness of timing and the priorities and aims of the whole operation. Instruct workers on means of recognizing manuscripts, materials with water-soluble components, leather and vellum bindings, materials printed on coated paper stock, and photographic materials.
5. Do not allow workers to attempt restoration of any spot. In the first 10 days after the Florence flood, when rare and valuable leather and vellum-bound volumes were subjected to scrubbing and processing to remove mud. This resulted in driving mud into the interstices of leather, vellum, cloth, and paper, caused extensive damage to the volumes, and made the later work of restoration is more difficult, time consuming, and extreme costly.
6. Carry out all cleaning operations, whether outside the building or in controlled-environment rooms, by washing gently with fresh, cold running water and soft cellulose sponges to aid in the release of mud and filth. Use sponges with a dabbing motion, do not rub. These instructions do not apply to materials with watersoluble components. Such materials should be frozen as quickly as possible.
7. Do not attempt to open a wet book (Wet paper is very weak and will tear at a touch. One tear costs at least one dollar to mend). Hold a book firmly closed when cleaning, especially when washing or sponging. A closed book is highly resistant to impregnation and damage.

PRESERVATION OF DOCUMENTS

8. Do not attempt to separate single-sheet materials unless they are supported on polyester film or fabric.
9. Do not attempt to remove all mud by sponging. Mud is the best removed by cloth when it is in dry condition.
10. Do not remove cover from books, as they will help to support the books during drying. When partially dry, books may be hung over nylon lines to finish drying. Do not hang books from lines while they are very wet because the weight will cause damage to the inside folds of the sections.
11. Do not press books and documents mechanically when they are water soaked. This can force mud into the paper and subject the materials to stresses which will damage their structures.
12. Use soft pencils for making notes on slips of paper but do not attempt to write on wet paper or other artifacts.
13. Clean, white blotter paper, white paper towels, strong toilet paper, and unprinted newsprint paper may be used for interleaving in the drying process. When nothing better is available, all but the colour sections of printed newspapers may be used. Great care must be taken to avoid rubbing the inked surface of the newspaper over the material being dried; otherwise some offsetting of the ink may occur.
14. Under no circumstances newly dried materials should be packed in boxes and left without attention for more than a few days.

PRESERVATION OF DOCUMENTS

NON-CHEMICAL METHODS

Most of the pests that damage library resources would not be affected by these toxic chemicals because they are so deeply imbedded in the volumes that they would not come into contact with the insecticide. Biological agents become immune due to successive use of chemicals. For these reasons librarians must look for new ways of controlling infestations by other means than the use of traditional insecticide sprays or extremely toxic chemicals. The use of neem leaves for insect repellent is the best conventional method of preservation among the non-chemicals. The use of neem leaves for insect repellent is the best conventional method of preservation among the non-chemicals. As traditional practice use of red colour cloth is also a preventive method from the attack of insects as insects does not tolerate the red colour. Pheromone trapping can be one such non-chemical approach. Improvement of environment is the other most effective means for preservation of cultural property. There are three broad and inter-related means : First, the design of the building, second the control of temperature, relative humidity, removing the dust particle and gaseous pollutants and proper ventilation and airconditioning, third the micro-environment. Screening at door & windows, caulking pest entry points are some of the controlling measures of biological agents which damage library materials. Most fragile documents are being restored by encapsulation with polypropylene and use of acid free electrically non-conducting board for preservation of archival documents.

THE NEEM LEAVES FOR PROTECTING PAPER MANUSCRIPT AGAINST INSECT ATTACK

Neem is a common medicinal plant found in India and other

PRESERVATION OF DOCUMENTS

oriental countries. Botanically it is *Melia azadirachta* and in English Margosa leave.

The powerful bitter smell of margosine acts as a good insects repellent. Hence, the use of dried green leaves is found effective in protecting textile materials and paper document against the attack of various kinds of insects.

It is a carboxymethyl steroid from the bark and leaves of neem. Its chemical formula, molecular weight and melting point are $C_{30}H_{36}O_9$, 540 gm and 204°C respectively.

S. P. Basak and D. P. Chakraborty of Bose Institute, Calcutta have chemically analysed a sterol, B-sifosterol (melting point 135-137°C, chemical formula $C_{28}H_{50}$) and a anthocyanine, quercetin (yellow compound, melting point (295-305°C). Chemical formula ($C_{15}H_{10}O_9$). The use of dried green leaves is due to the presence of quercetin which is known to have antibacterial and antifungal action. Dried green leaves are used for controlling household pests like *Anthrenu scrophularcae* (carpet beetle), *Tinea pellionella* (*clothes moth*) which destroy wool, hair, feather and fur.

PROCESS OF NEEM LEAVES

Freshly plucked neem leaves are dried in shade by spreading on a big piece of clean cloth. The time period of drying fresh neem leaves depends upon the existing season. Normally it takes 10 to 15 days. In fresh condition, the colour of the leaves is shining deep green, but after drying it becomes dull deep green. These dried green neem leaves are the most suitable for use against insect attack from the conservation point of view. when the dried leaves are left for about four months. The colour of the leaves is turned to brownish grey from dull deep green. In this condition, the leaves do not

PRESERVATION OF DOCUMENTS

remain as effective as the leaves were in dull deep green condition. Hence, the brownish grey leaves should be replaced by dull deep green leaves. In other words, we can say that the dried leaves should be replaced at the interval of every four months.

USE OF DRIED NEEM LEAVES

Dried green leaves are spread thoroughly on the surface of the bottom of the box or on the lower surface of every shelf of the almirah. Dried green leaves are also placed in several folds of the books and documents. Then the paper manuscripts are kept properly in the shelves of the almirah or in the box. After keeping the clothes or the paper manuscripts in the box or in the almirah, the whole space is thoroughly covered with the dried green leaves and then the box or the almirah is closed.

PRECAUTIONS

- i) Freshly plucked neem leaves must not be dried in the Sun. The reason behind this is that the rapid drying in the Sun makes the leaves stiff and fragile.
- ii) The drying place of neem leaves must not be damp and this place must have proper ventilation, otherwise, the leaves will begin to rot.

Only properly dried green neem leaves can be used

Freshly plucked neem leaves must not be used because

- i) Fresh leaves will rot themselves and will create another problem.
- ii) Fresh leaves also leave green stains on the textile

PRESERVATION OF DOCUMENTS

materials and paper documents and

- iii) Fresh leaves are not as strong as the dried green leaves.

Advance of using dried green neem leaves on insecticides

- i) Neem leaves do not pollute environment at all.
- ii) Its use is not dangerous at all.
- iii) It is abundantly available everywhere and every time and
- iv) Its use is the most economical too.

Environment Control

The library materials which are kept in a room should be free from dust, airpollution and maintains ideal humidity and temperature.

Cleaning, handling & storage

Cleaning of dust and dirt from collection is important for preventive preservation of library material. Air conditioning is a costly affair and is not feasible to have in all libraries and Archives in India. The use of cloth duster is an age old practice for cleaning of dust from records. Perfect cleaning of dust is possible with electrical operated vacuum cleaner such as Mono, Di and Trivac which are used in the National Library. Floor of the stack area should be cleaned by the vacuum cleaner. Proper cleaning helps to bring down the frequency of insect attacks. Periodic inspection of stack area will help in eliminating the possibilities of insect attack. Newspaper and periodicals, journals and ephemeral loose collection should be packed to hyfex bag on the shelves to enable free air circulation for preventing high humidity and dust. Most brittle collection should be handled carefully otherwise it may damage further.

PRESERVATION OF DOCUMENTS

The collection should be handled with clean or dry hand. Smoking should strictly be prohibited in the stack area to avoid fire accidents. A fire alarm is set up in this library as safeguard to accidents. The necessary fire extinguisher should be available in the library to control the fire. Flood and fire damaged materials require specialised treatment by scientifically trained personnel.

Light Control

There are two types of lights inside the library—natural and artificial light. Far ultra violet rays of natural light (below 4000Å) emit from the Sun which causes direct break down of the cellulose structure. The glass panel of the window is used to cut off this ray. On the other hand, near ultra-violet rays are low visible, light radiation 3400Å-5000Å which causes indirect destruction of cellulose which blackens coloured paper. This ray can be prevented by plastic screening which reduces the intensity of Sun light. Secondly white paint (Titanium oxide pigment) on a roof or wall will further absorb near ultraviolet radiation. Traditionally old manuscripts can be wrapped in red coloured cloth. To some extent it also prevents insect attack. Day light damages the objects more than incandescent and fluorescent light. Fluorescent light should be filtered.

Air Conditioning

Fluctuation of temperature and humidity is very high in India as it is a tropical country. The humidity and temperature play vital role in the ageing of paper and any organic base materials. Higher the temperature the rate of reaction on the paper is high and as a result cellulose breaks down. By air conditioning system suspended aerosols are screened from air by filter. Sulphur dioxide can be partially removed from air by frequent

PRESERVATION OF DOCUMENTS

recirculation through activated charcoal filters. Pure water will remove all the gases. The humidity and temperature should be maintained at $45\% \pm 5\%$, 18°C for microfilm and 21°C in case of paper.

Other methods

Curtains are used to cover windows and doors for controlling heat and dust during summer and spring seasons. If the humidity is high in the rainy-season (75% to 95%) this should be brought down by dehumidification. Silicagel is used in a small compartment to absorb the moisture. Hot air fan can be used for the same purpose.

Encapsulation

The process of encapsulation can be described as trapping an item between two sheets of clear inert material (polyster, polypropalene) which is sealed or fastened around the edges. Encapsulation is suitable for protecting paper items and photographs but is not suitable for pastels.

Encapsulation differs from others more traditional forms of support such as lamination or attached to the encapsulating material in any way. It is simply held in position, trapped between two surfaces which form a physical barrier against potentially harmful external forces. The polyster barrier is very tough and effective in protecting against handling and abrasion. It is impervious to water but allows the slow transmission of vapours. In this way, a slow exchange of air is allowed but any temporary fluctuations in the environment are unlikely to affect encapsulated item.

All edges can be completely sealed or tiny gaps can be left at the corners to allow an increased exchange of air. Research by the Library of Congress suggests that this increased exchange helps decrease the rate of deterioration but

PRESERVATION OF DOCUMENTS

the difference is very slight, moreover, there are disadvantages in allowing for an accidental exchange of any harmful gases and reduced protection in a disaster situation.

The single sheet encapsulation is most common, several encapsulated sheets can be assembled in book form.

The advantages of encapsulation are

- 1) It gives excellent support and protection with minimum interference to the original item;
- 2) There is no visual interference to the study of a print or manuscripts or rare documents;
- 3) Fragile and heavily used items can be consulted without risk of damage;
- 4) Encapsulation is instantly and fully reversible;
- 5) Encapsulation gives protection in a disaster situation especially from water.

Methods of sealing

There are various methods of sealing or fastening the edges of an encapsulation. They are :

Ultrasonic welding

Electro-magnetic welding

Double sides tape

Sewing

Welding-preferred methods are the safe methods of welding. Periodical check is needed if adhesive tape has to be used. In

PRESERVATION OF DOCUMENTS

the two welding processes the polyester or polypropylene sheets are fused together along a fine line by a controlled line of heat which melts the polyester while the two surfaces of the encapsulation are in contact. Polyester used in various thickness 50,75 and 100 microns according to the size of the documents. Polyester requires an extremely high temperature to melt because of the control that is required to produce a line of weld at the correct temperature for a high quality result, welding has to be carried out with either ultrasonic or electromagnetic equipment. The ultrasonic welding process used friction to generate a high temperature. A generator converts the standard electrical current from 50 cycles per second to 40,000 cycles per second. This electrical impulse is converted to a mechanical vibration transmitted through a probe which contacts with the polyester, is moved along the line where the weld is required. A good number of polyester encapsulation of a document has been done here manually with double sided adhesive tape. The National Library, Calcutta has set up a modern productive ultrasonic welder for encapsulation of antiques.

Sewing

The edges of the polyester can be sewn together using either a straight stitch of sewing needle or sewing machine. Using double-sided adhesive tape outside the area to be sewn to prevent movement of the polyester, a line is sewn around the encapsulated item after which the edges are trimmed to leave a neat line around the sewing. This produces a safe encapsulation which can be quite neat if sewn carefully but has the disadvantage of bulking up at the point of sewing when several encapsulations are put together.

Whatever method is followed, all air must be excluded between the sheets of polyester before edges are sealed. It is also important to try to stabilise paper items chemically.

PRESERVATION OF DOCUMENTS

Both cases the documents are required to be deacidified through the process which is suitable for the same.

Pheromone Trapping Programme in Library

Pheromones are chemicals secreted by insects in order to modify the behaviour of other insects belonging to the same species. They include sex attractants, aggregation pheromones and pheromones which stimulate mass attack or feeding or which mark territory boundaries.

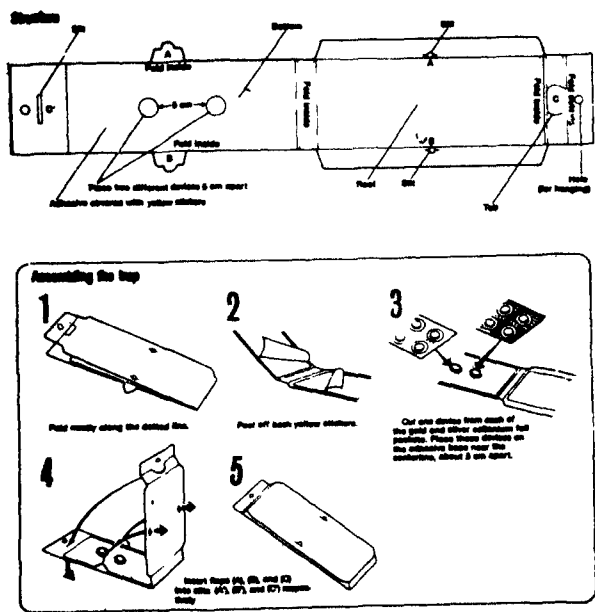
Trapping insects is perhaps one of the most underutilised effective, non-chemical methods, but care must be taken in the selection and placement of traps. For instance, electrocutting light traps can be very valuable in trapping flies indoors, but if placed outside they may attract many more insects that they kill and result is worse pest problems. Traps can be used both to achieve control and monitoring the types and locations of pests. Regular checking of traps can indicate when an infestation began have provide due to the origin of the infestation.

The potential uses for such traps are constant and spot monitoring, locating infestations, drawing and detection, evaluation of control, techniques, mass trapping, mating disruption.

Pheromone monitoring programmes give management an excellent tool for detecting adult book worms and for pinpointing the location of an infestation. The traps are usually placed out of sight on top a light fixture or on top of a double row of shelving. They may also be hung vertically from a light fixture. The newer trap, known as the "New Survico" trap for cigarette beetle monitoring and control is shown in Figure 1. It is a card board trap with a sticky material on the interior top and bottom. Two dishes of pheromone attractants are placed

PRESERVATION OF DOCUMENTS

on the sticky materials as shown. One dish carried the sex pheromones known as serricornin this mixture of pheromones is much more active to the male beetle than previous combinations. A second disc, a good attractant, is placed adjacent to the sex pheromone disc and is extremely effective in capturing female beetles. A permeable plastic film releases the pheromone into the air in a controlled manner. After the pheromone device is in place, the trap is folded in such a way that the beetles enter through the open sides. Each trap provides two months efficacy. The traps should be stored in a dark, cool place before use, and protect from direct sunlight and wind when it is used.



The "New serrico" cigarette beetle trap. This unit utilizes both a sex and food attractant pheromone system to lure both sexes of beetles to the trap.

PRESERVATION OF DOCUMENTS

Electrical ^{mm} Conductivity Box

Boxing facilitates to protect the current state of documents from further physical damage and also to offer some sort of elevate to adverse environmental conditions by providing a more suitable micro-environment around an individual item.

Advantage

Misshandling causes physical damage to manuscripts, pictures, palm leaf, especially when those materials are in any way unstable. Boxing provides some protection against such damage.

Dirt and dust too caused damage and provide an environment in which moulds may flourish. Cleanliness is a major factor in any preservation programme. It can be greatly assisted by boxing. The document is cleaned before it is boxed. Boxing can protect the materials from ultraviolet rays which damage paper. Boxing will also provide protection from acid migration from one material to another on the library shelves. It also help protect in the event of minor disasters such as a small flood or fire. The choice is not simply between boxing and building. Both approaches will probably play a part in the overall preservation programme. Boxing will certainly be cheaper initially than binding but it may not be the correct solution for the particular circumstances in a given library. Boxing may well bulk the collection. It is most economic preservation process, if long term retention in current condition is required.

Specification for materials to be used in boxing programme. All materials used in the preparation of boxes for storage should be archival standards where long term storage is considered, all boxes should be made from materials of permanent archival quality. Electrical conductivity board must

PRESERVATION OF DOCUMENTS

be used which contain acid free-covering materials-cloths, leather, paper and linen materials. C.M.C. with may be used as adhesive in this regard.

A acid free archival paper-lining on the inside of the box will help buffer, the board from the material stored by this should be relied upon in the long term. Boxing of photographic or sensitive, tarnishable materials, the board must be unbuffered and completely silver-safe and also be free from chloride and other harmful oxidising agents.

The following specification of Box is recommended as a minimum requirement for preservation of library materials

Fibre	Neutral highly refined chemical pulp
p ^H	7.0 -8.5
Light fast	Blue wool scale reading of 5
Sizing	Neutral sizing
Buffer	3% Calcium Carbonate
OBA	Free from optical brightening agents
Reducible Sulphur	Not more than 0.8 parts per million
Adhesive	Archival neutral adhesive

Polythene folder

It protects the current state of periodical and newspaper etc. from further physical damage and to offer some sort of palliative to adverse environmental condition by providing a more suitable micro-environment around an individual item. Folder is only one part of an integrated preservation and conservation effort. Folder is method of protection which does not interface with the item itself. It is the best method of preservation of loose journals, periodicals and newspapers. Folder can protect the material from ultraviolet rays which damage paper. It also provides protection

PRESERVATION OF DOCUMENTS

from air pollution such as SO_2 , H_2S etc. and migrate one material to another on the library shelves. It also protects in the event of minor disasters such as a small flood or fire. Dust and dirt accumulates on the periodicals and newspapers on the shelves in the Library. The problem is partially solved by using polythene folder. Folder will certainly be cheaper than binding.

Preparation of polythene folder

Red colour insect repellent 1 mm thick polythene is used for preparation of folder. The polythene folder is about 18" length, 14" breadth and 4" width size where 4 months newspapers can be accommodated. There are two bottoms at the mouth for closing system of the folder. One pocket about 5" x 4" size is set up on the width where catalogue card is inserted for use of content. The dust particles accumulated on the folder which may clean easily by vacuum cleaner periodically. Red colour folder is the best to protect from insect attack which is also insect repellent.

USE OF LOW TEMPERATURE

Insects become inactive at 50°F or below, and if room temperature are kept at this level no insect infestation would progress. However, many insects can remain alive at 50°F and lower, in a kind of dormant state, and if the temperature is raised they will resume their activity. In order to kill most insects, the temperature must be kept at 0°F for one or more days. The egg stage is usually the most difficult to kill with low temperature.

ANOXIC TREATMENT

Anoxic treatment is very interesting in which the oxygen content is reduced below 0.1%. This condition may be

PRESERVATION OF DOCUMENTS

achieved either by vacuum or nitrogen back fill. By absorption of the oxygen in the air, i.e. Using oxygen absorbing agent ageless. The low oxygen level must be held at least three weeks.

The China first invents paper in the 105 A.D. in Asia minor, now a days who are using a special type of Chinese paper prepared from xiam coo perfumed grass which is mainly repellant of the insect. They use camphor wooden box which prevent the rare document from the air pollution. The spoiled positions patched up by xiamg paper with starch paste which are one side printed. They adopted freeze drying method of insect control.

Folded Boxes

Tools and materials required

Long straight edge

1 ft. steel rule with mm

Thick bone folder

Edding cutter M1 19

Curved chisel and hammer or corner rounder

Creasing device

Grey/white board

Strips of thick plywood, or similar, 2" deep and in inch lengths 4" to 12" long in pairs. Another set 3½" deep

At least 6 g clamps.

If you have no creasing machine a simple aid for making creases can be made from millboard. (1)

Measure the book accurately in mm. noting the W=width, H=height, D=depth. (2)

To calculate the board size for the box, use the following formula

PRESERVATION OF DOCUMENTS

W x 2 plus D x 5 plus 15

H plus D x 4 plus 18

For a book measuring W = 120mm H = 200mm D = 25mm

W x 2	=	240	H	=	200
D x 5	=	125	D x 4	=	100
plus 15	=	15	plus 18	=	18
		380			318

Cut board slightly larger, with the grain direction running head to tail.

Have the grey side facing up and landscape.

Mark bottom right corner with a star ☆.

On the steel rule indicates the measurements of the book.

Start measuring from the right hand side and work to the left, making creases as you go. (3)

1st crease D 2 (25-2=23 make crease 23mm from right edge)

2nd crease D (make 2nd crease 25mm from centre of 1st crease

3rd crease W +3 (etc)

4th crease D +3

5th crease W +7

6th crease D +3

D +1 cut away excess board on left

Turn board so ☆ top right. Work right to left.

7th crease D +1 crease from bottom edge up to 4th crease

8th crease D +3 crease from bottom edge up to 3rd crease

Turn board so ☆ bottom left.

9th crease mark to right of 8th crease

PRESERVATION OF DOCUMENTS

Work right to left

10th crease D

D -2 cut away excess board on left up to
3rd crease from 9th crease work left
to right

11th crease H +4 from centre of 9th crease

12th crease D

D -2 cut away excess board on right up to
3rd crease

Turn board so ☆ top right

13th crease 3mm to left of 11th crease. Should also be
H + 10 from 8th crease.

Work to the left

14th crease D +3

D +1 cut away excess board

Turn board over white side up.

Fold crease 1 - 6

Ease up crease 8 & 9 also 11 & 13 so ridge appears

- (4) Cut away ridge of 3rd crease to just above 9th crease.
Cut away ridge of 4th crease with a diagonal cut just
above 9th and 8th crease
Repeat other end.

Fold all head and tail creases.

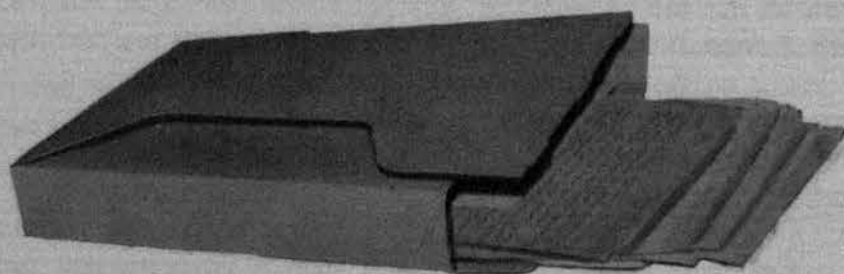
Looking at (5) and (6) cut out relevant pieces to make corner
tabs.

- (7) Glue inner white walls between creases 8 and 7 and
both sides of tab B. Fold tab A to outside, life whole of
base side wall upright, fold over and down tail wall
trapping tab B inside. Ensuring a tight fit, place two
pieces of wood on either side of wall and clamp. Repeat
with base head wall, and the lid head and tail walls.
Glue both sides of long corner, tabs and inner wall, fold
over and down trapping tabs. clamp between strips of
wood.

PRESERVATION OF DOCUMENTS

Glue down spine tabs.

With curved chisel and hammer remove sharp corners of head and tail walls adjacent to spine. Punch inwards on base walls and outwards on lid walls. Punch a thumb crecent out of centre of lid side wall to facilitate opening of box. This type of box is used by British Council Library, London.



Folded Box

PRESERVATION OF DOCUMENTS

BOOK BINDING AND GOLD TOOLING

Book binding is an art. The subject write or print on papers to be bound first. The reasons for binding is that the leaves of a book are to keep together in their proper order and to protect these for future. The performance of binding, i.e., the ease with which a volume can be opened and closed, and the protection which it affords to the inner sheets depend on the binding processes, while its durability depends on the quality of the materials selected for binding.

More than 8 processes combine to produce a bound volume, and the recommendations contained in the Indian Standard Code of Practice for Reinforced Binding of Library Books and Periodicals (IS : 3050-1965) hold good for archival bindings.

At all times difficulty has been found in preventing the first and last sections of a book which are dragging away when the cover is opened. So it is advisable to put a good number of blank papers at each end, as these papers are part of the binding.

On receiving a book for binding, the physical condition is to be examined first. If the sections of a book are in loose form then these sections have to be opened directly. But the sections which are in folded position, then care should be taken to open individually so that each section would remain intact.

1. First opening a book thoroughly cleaning its spine, check up whether any damage leaves, if so, mend with tissue paper partly or whole. Now paste four pages front and back for strengthening the flying pages.
2. Sewing is necessary where a book is more than one inch

PRESERVATION OF DOCUMENTS

thick. It is done by saw. Keeping four equal distance high, it is to be made for inserting thread which is attached with the board later on.

3. Sewing :— (1) Stitch sewing. (2) Cross sewing. (3) Section sewing (4) Overcast sewing, sewing depends on its physical condition and size.
4. End paper :— Single end paper and double end paper. Double end paper contains three flying sheets. One is pasted flying sheet attached with the inside of the board, single end paper is one sheet folded only and it is used where the book is thin.

HOW TO SEWING OLD BOOKS

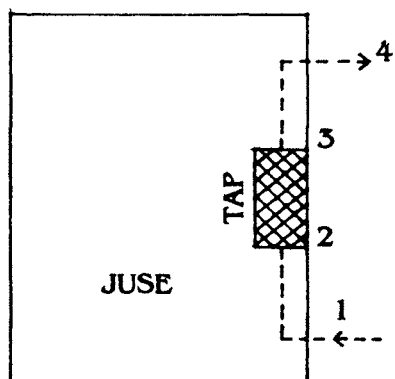
For an old book sewing, three systems are as follows :—

1. Section sewing 2. over cast sewing 3. stitched sewing.
- A. One section and one tap by four stitches.
- B. Two sections and two taps by six stitches.
- C. One section and two taps by six stitches.
- A. One section 1 tap by four sticthes.
- A. After arranging the sections, give a pencil mark below 1½" from head and tail side. Now, give equal two marks between head and tail marks. Now, it completes four marks. There will be four stitches within the given four marks. See picture No. 1. Now, keep the folded sheet which is called forma on your front. Keep its head on the front and folded side on your right side position so that one can easily insert the thread by needle on right hand. Now insert the needle with thread at the mark No. 1 and bring it out through inside the forma where it is folded hings to mark No. 2. Similarly insert in to the mark the thread No. 3 and bring it out from mark No. 4. Always

PRESERVATION OF DOCUMENTS

keep it in mind when the thread will bring out from mark No. 2 and again inserting the thread in to the mark No. 3 there will be a gap, which is to be filled up by 1" cloth or rexin, it is called "Tasma" which is used for tightening the spine of a book. Now, the thread coming out from mark No. 4 similarly again keep the forma as said before. Insert the thread at the mark No. 4 and bring it out from mark No. 3.

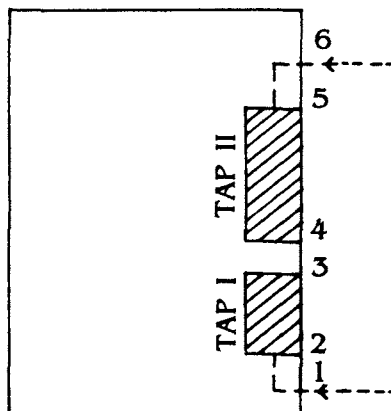
The needle again insert in to the mark No. 2 and bring it out from mark No. 1. Now, the starting point and finishing point are to be knotted together. Thus placing the 3rd forma and sewing it in the same way & the needle is to be brought out from mark No. 4. Now, it should be noticed that the 1st and 2nd forma where both are joined with sewing at the mark No. 14., make it twist between 1st and 2nd forma. Now, the 4th forma is to be started the sewing forma mark No. 4 and it is finished at mark No. 1. and the needle will go through the middle of 2nd and 3rd forma for twisting. Thus the process mentioned above will continue till the end of books forma



PRESERVATION OF DOCUMENTS

B. 2 tap 2 section 6 stitches.

At this stage 2 tap on a forma and six stitch is to be adopted now. The needle is to be inserted through mark No. 1 and it is to be brought out from mark No. 2. using 1st tap, the thread is to be inserted from outside of the forma and to be inserted the needle through mark No. 3 and is to be brought out from mark No. 4. Using 2nd tap the thread is to be inserted through mark No. 5 and bring it out through mark No. 6. Now, take the 2nd forma and bring out the needle through mark No. 1. Now, the running thread in to the section is to be tightened up and twisted it with the thread which is left before on forma No. 1. This is to be continued till the last forma of book.



5. Gluing up :— The back of the book is glued up. The glue for this operation must be hot and not too thick. The glue should be worked well between the sections. It is better to rub the back with a finger and make sure that the glue goes between every section for its entire length.
6. Trimming :— If the edges of a book are to remain uncut it apparently looks ugly, so, it must be trimmed.

PRESERVATION OF DOCUMENTS

7. **Board Cutting :—** Board is a safe guard of a book. It protects the book from injury. So, it is slightly bigger than book.
8. **Rounding :—** Rounding is done for backing purpose.
9. **Backing :—** Backing is required to make a very fine high according to thickness of a board.
10. **Head and tail band :—** Head and tail bands are an one inch binding cloth folded its one third inserting a thick cord. It is pasted on the back edge of the book. It resists the strain on the book when it is taken from the shelf.
11. **Back paper :—** Back papers are three or four folded equal to the wide of a back of the book. It is used for placing inside the extra cloth which has been attached on spine or back. Moreover, it makes hollow system.
12. **Leather, $\frac{1}{2}$ or $\frac{1}{4}$ leather binding :—** The leathers are used where the book is very important and rare used, otherwise it is advised to use canvas for regular use of the book, leather pairing is necessary so that its edge from four sides are softened while throwing up in to the hollow back paper.
13. **Cloth :—** Now after attaching the spine and corner of the book it remains open some portion which is to be covered by cloth.
14. **End paper :—** The last item is the attaching the end papers. Both sides of a book the last flying pasted paper is to be pasted with the back of the board.

PRESERVATION OF DOCUMENTS

BINDING EQUIPMENTS



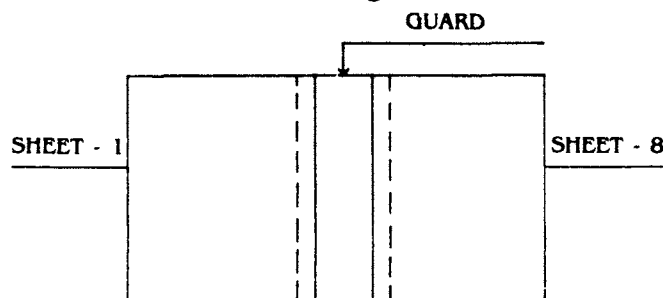
Equipment of Binding

Binding of laminated sheet

The different stages of binding, guarding, stitching back rounding and backing, fixing board and covering etc. are all carried out manually. Only the best materials from thread and tape to board leather should be used. The binding primarily for conservation purpose, the accent is on both durability and permanence and it is, therefore, essential that the workmanship be of a high calibre. Documents repaired as single sheets are collected and then guarded into sections. A section usually comprises eight sheets although it may consist of twelve or sixteen sheets. The two largest sheets of the lot are placed on the work table and a measure is drawn. The measure comprises two widths of the sheets plus 4 cm for the guard. Thereafter, guard strips of 8 cm width and slightly longer than the sheets are to be cut. Hand made paper should be used as guard.

PRESERVATION OF DOCUMENTS

Each section of eight sheets is joined by means of the guard by placing the sheets in position on the work table in such a way that sheet 1 is joined to 8, 2 to 7, 3 to 6 and 4 to 5, each set of sheets being placed over the other in a step ladder information as shown in figure.



The width of the guard decreases progressively to permit even folding of the sheets, if this is not done, the inner set of sheets will produce outwards. Each successive section of sheets is guarded similarly.

Such guarding. is properly carried out :

- a) to enable the stitching of the volume to be done on newspapers i.e. guards and saves the original weak paper from the stress and strain of stitching and hence tearing during use, (b) leaves any marginal inscriptions clear thus permitting easy handling of bound sheets and easy deciphering of such inscriptions;
- (c) facilitates the microfilming of bound records; and
- (d) permits the formation of a compact volume,, as sheets of unequal dimensions can be made up into sections of uniform size for binding.

In the Library, a strip of tissue paper 3 cm wide and same thickness of document is pasted as a guard on the folds of the sheets forming a section. In the inner set of sheets, the guard strips is pasted inside the fold, while on the outer set

PRESERVATION OF DOCUMENTS

of sheets, the strips is pasted outside.

As a result of guarding the thickness where the guard paper has been edged on the document, is greater than that of the back, i.e. at the folded guard. To achieve uniform thickness, slips of paper 4-5 cm wide i.e. slightly less than the width of the guard are folded and placed between the folds in each section. These extra slips called the "get in" paper are placed inside each section and not on the outermost side. After completion of this stage, the sections are given a nip in a nipping press to reduce the swell at the back. Excess guard and 'get-in' paper at the tail and is then trimmed off and the volume stitched on taps. The stitching is flexible all along i.e. the thread is passed through the inner folds of each section to ensure flexible opening of the volume. After the sections have been stitched, end papers usually hand made paper thicker than that of the volume itself are prepared and stitched in the same manner as the sections.

The back of the stitched volume is rounded. The old document should be rounded back by hammer. The boards are cut square and laced to the tapes and then covered. Volumes containing laminated paper are bound in half leather and have hollow backs. In other volume, the leather is fixed directly to the back so that they have light backs. Binding of old rare books is carried out in accordance with the specifications drawn up and existing in almost all countries for first class binding by hand.

GOLD TOOLING

Gold tooling is an impression of a heated stick. It is made up of brass and called composed stick. The impression types are kept in classified system. It is left in gold upon the surface of a bound volume which may be leather, canvas or cloth etc.

PRESERVATION OF DOCUMENTS

Fillers are cut with two or more lines on the edge. It is impressed on the round spine of a book.

The first thing of the gold lettering is to be applied the albumen on the surface of a book where impression is to be done, keep aside for four minutes for dryness. Get the matter ready which is to be impressed and keep the matter in the composed stick. Give tight the book in the lying press, keeping half of the book out side of the lying press. Now, warm up the filled stick but not too hot. Place the gold foil on the place where the matter is to be impressed. Now, give medium pressure by the stick & see the result, if it is not clear, do it again. If the book is a leather binding then polishing is necessary. It is done by rubbing the hot polisher for the glittering of the leather.

Gold Tooling instruments

- | | |
|------------------------|----------------------------|
| 1. Composed stick 8" | 5. Pincer (Small) |
| 2. Fillet 4" oval type | 6. Wooden piece oval type |
| 3. Polisher | 7. Type No. 10-12 |
| 4. Lying press (Small) | 8. Type distribution Boxes |



Gold tooling

PRESERVATION OF DOCUMENTS

BOOK BINDING ADHESIVES

Ethylene copolymer based hot-melt adhesives are currently being used in a variety of applications. One of them is Book Binding Adhesives. Hot melt book binding adhesive does not only bind the individual pages of a paperback book together, but also attach the cover. For optimum performance, the adhesives must have excellent flexibility, toughness, and fatigue resistance. These proper ties must be maintained at elevated (140°F) and low (0°F) temperatures over long periods of time.

Ethylene copolymers, primarily 28 to 30% VA EVA copolymers, are used to provide the necessary flexibility and toughness. Lower VA copolymers have better elevated temperature. But poorer low temperature flexibility and more stiffness. Medium to low melt index copolymers are predominantly used for book binding applications because these seem to have the best balance of performance and melt viscosity.

Book binding hot melt adhesives are formulated with modifying resin waxes and occasionally plasticizers. The modifying resin must not stiffen the adhesive too much. For this reason Polymerised rosin and its ester, as well as other high molecular weight rosin derivatives are used to promote adhesion. Hydro-carbon resins are sometimes, used as plasticizers of various types and have been reduced viscosity and stiffness. The low molecular weight types are often fugitive and migrate into the paper pages and cover. This can be used to advantage when a very high level of toughness and flexibility are required: plasticizers can be used to temporarily reduce the viscosity of a high EVA content adhesive to an acceptable viscosity range. After aging, during which the plasticizer migrates into the paper a tougher than

normal adhesive now remains as the binding.

Origin of Adhesive

The organic and semi-organic adhesives may be classified as :

1. Natural : Starch, dextrin asphalt animal and vegetable Protein, Natural rubber.
2. Semi synthetic : Cellulose nitrate and the Carboxymethyl cellulose, polyimides derived from dimer acids.
3. Synthetics :
 - a) Vinyl-type addition polymers, both resins and elastomers, polyvinyl acetate, polyvinyl alcohol acrylics, unsaturated polyesters, butadiene acrylonitrile, butadiene-styrene, butyl rubber, neoprene.
 - b) Polymers formed by condensation and other step-wise mechanism :- epoxies, polyurethanes, polysulfid rubbers.

Adhesive films

Both thermosetting and thermoplastic adhesives are available in film form. They are uniform in both composition and thickness convenient to handle, free from volatiles. The thermoplastic film is employed for metal to metal bonding in aircraft, as well as less demanding appliance, electrical and automotive requirement. These adhesives are hybrids designed to provide an optimum combination of shear strength, elongation, and heat resistance. In case of thermoplastic resins, the monomeric units are linked together so as to form two dimensional linear chains with the result that the materials is soluble in an appropriate solvent. On the other -

PRESERVATION OF DOCUMENTS

hand, thermo setting resins are linked together by chemical bonds to form three dimensional network. These materials are in fusible or insoluble in all solvents. They may swell form gels in some solvents or may be broken chemically to form soluble products.

Plasticizers are those materials which are added to synthetic resins to modify their physical properties and particularly to confer added flexibility to resins which may be otherwise brittle. A plasticizer must remain in film throughout the useful lifetime.

ANIMAL GLUES

Composition : Animal glue is a protein derived from the simple hydrolysis of collagen which is a principal protein constituent of animal hide, connective tissue and bones.

Collagen, animal glue, and gelatin are very closely related to protein and chemical composition, and as a group is presently the subject of broad research in protein, adhesive, food, leather and medical field.

Hof Meister considers gelatin (glue) as hydrolyzed collagen.
 $C_{102}H_{149}O_{38}N_{31} + H_2O = C_{102}H_2H_{151}O_{39}N_{31}$

Which gives as approximate chemical composition for glue of

	%
Carbon	51.29
Hydrogen	6.39
Oxygen	24.13
Nitrogen	18.19
	<hr/>
	100.00
	<hr/>

PRESERVATION OF DOCUMENTS

As a portion, animal glue is essentially composed of polyamide of certain alpha-amino acids. The amino acid present in animal glue have been investigated thoroughly by Eastoe, Neuman, and pouradier. It is believed that the amino acids are present in animal glues in the free state but rather than residues which are joined together by the elimination of water to form long polypeptide chains.

Animal glue is a polydisperse system containing mixtures of similar molecules of widely different molecular weight. The molecular weight of animal glue is always an average. A wide range of molecular weight is reported ranging from 20,000 to 250,000.

APPLICATION

Animal glues have long been accepted as a standard product where economy, strength, permanence of bond for book binding with cloth and versatility are of prime importance. In the more common use of the dry glues of commerce, the usual adhesive solution is prepared at 40 to 50% concentration at 145°F to give a point like fluidity which permit ready spreading and deposition of a thin, continuous adhesive films at the joint. The inherent property of animal glues so applied to thickness on slight cooling permits the rapid development of desired tackiness and also serves to hold the adhesive at the joint surface, eliminating the danger of excessive bleeding from the joint on application of pressure.

Procedure of application

The time-factor principles governing the use of animal glues as an adhesive are few in number.

1. Deposit a thin continuous glue film on the surface only

PRESERVATION OF DOCUMENTS

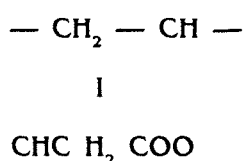
of the matching adherends or joint faces.

2. permit the glue film to thicken slightly to a tacky condition prior to applying pressure.
3. Apply pressure adequate to squeeze out excess glue and bring perfect contact over the entire assembled area.
4. Hold under pressure long enough to ensure an initial bond strength in excess of the stresses inherent in the specific glued assembly.

Thermoplastics

Polyvinyl acetates and polymethyl acrylates are two groups of most durable thermoplastics. They form colourless films and are highly resistant to discolouration and give good gloss to the surface.

- a) Polyvinyl acetate. The molecular chains of this chemical composition is

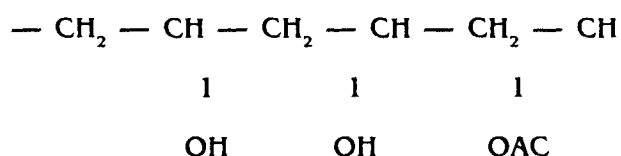


It has good stability to light, severe exposure to light may increase sensitivity to water but does not cause yellowing and the polymer remains fully soluble. It can be dissolved in toluene and aromatic solvents and also in lower alcohols with small addition of water. It is also soluble in esters and ketones. For single coat, varnishes avoid high viscosity on one hand and too soft resin on the other hand. Best chosen viscosity is between 4 and 15.

PRESERVATION OF DOCUMENTS

Polyvinyl Alcohol

This is produced by the partial or complete hydrolysis of polyvinyl acetate to form the units of formula.

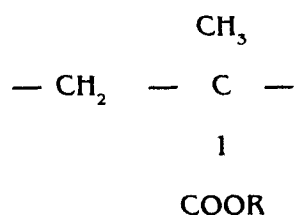


Polyvinyl alcohol

It has good stability to light. But in strong light and in dry conditions cross linking of units may occur yellowing and instability occurs from heating above 100°C. Water is the only practical solvent. Weak solutions with no disinfectant may be subjected to fold growths. To combat this low concentration of chlorinated phenol may be added to it and gives good strength and flexibility. Polyvinyl alcohol has an unusually low permeability to those atmospheric gases which are not very soluble in water.

Polymethyl acrylates

The molecular chain is composed of



units, where R represents polymethyl methacrylate, polyethyl methacrylate and poly-n-butyl methacrylate. It had good stability to light and is also stable to temperatures upto

PRESERVATION OF DOCUMENTS

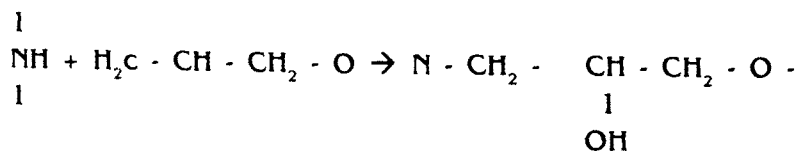
200°C. Polybutyl methacrylate can be dissolved in aromatic hydrocarbons such as toluene and turpentine. Polymethyl methacrylates are more difficult to dissolve, but will give a relatively low viscosity solution in an 80/20 mixture of toluene and methyl alcohol. Solutions and emulsions of methacrylates and acrylate polymers are available in the market. They give tough glass clear films. There are two important groups in the first, one loss of volatile material usually water occurs during setting reaction, where as in the second, the setting occurs without any loss of volatile material. In such adhesive where there is no loss of volatile material there is no appreciable shrinkage and therefore their merit of particular consideration in conservation.

EPOXY RESIN

The epoxy, epoxide, oxirane or ethoxyline Group is a three membered ring consisting of an oxygen atom attached to two connected carbon atoms.

The term "epoxy resin" usually refers to an intermediate molecule which contains at least two reactive epoxy groups such as resins which are categorised as "thermosetting". Since they are capable of "curing" to form crosslinked net-work. The rings can be opened by either acidic or basic materials, functioning either as catalysts for homopolymerization or as reactive hardeners.

The most common epoxies used in adhesives are derived from bisphenol A and epichlorohydrin ("bis-epi" resins) and are usually cured with reactive hardeners containing primary or secondary amine groups :



PRESERVATION OF DOCUMENTS

Aliphatic primary and secondary amine reacts with epoxy groups rapidly at room temperature, but aromatic amines require elevated temperature cures. Each hydrogen atom attached to nitrogen is capable of opening an epoxy ring. In order to crosslink a diepoxide, primary amine must be a polyamine. The amount of amine required may be calculated by allowing one amino hydrogen atom per epoxy group. There are one or more advantages of epoxy adhesives such as lower cost, less shrinkage, lower coefficient of thermal conductivity, better electrical properties, fire retardance etc.

Epoxy resins are among the latest additions to the range of synthetic adhesives, they consist essentially of viscous resins component having an epoxy ring. These resins are most versatile type of adhesives and they can form strong bonds between all kinds of surface.

Formulations

A. General purpose Adhesives.

General purpose adhesives are obtained by formulating with amidoamines. Some typical adhesive formulations based on standard liquid epoxy resin (eq wt. = 180-200) are as follows :

- | | | |
|----|----------------------------|------------|
| 1. | Epoxy resin | 100 parts |
| | Versamid 115 or equivalent | 70 parts |
| | Filter or resins forcement | as desired |

B. Flexible Adhesive

C. One component Adhesive

D. Quick cure adhesive

E. Power adhesive

F. High Temperature Adhesives

PRESERVATION OF DOCUMENTS

Type adhesive

Polyglycidyl ether of 1,1,2,2,2-tetrakis (4 hydroxyl phenyl) ethane (epoxy value 0.45 eq/100g) — 80 parts

Tetrahydrofuran	55	parts
Epon 100g	20	parts
Polyvinyl formal	20	parts
Aluminium dust	100	parts
Diaminodiphenyl sulfur	24.5	parts

The adhesive is deposited on a glass cloth and dried at 200°F for 15 min. cure, 30 mins at, 240°C

Carboxy methyl cellulose

Sodium salt of carboxy methyl cellulose has shown excellent properties as an adhesive in very low concentration in water, carboxy methyl cellulose good quality solution is used as tissue lamination of rare document manuscripts which is continuous process in the National Library.

To prepare the parts, a measured quantity of water (2 lits) is heated to 80-90°C. The heating is discontinued and sodium salt of carboxy methyl cellulose is added in small quantities gradually. Stirring till a concentration of 3 to 5 percent (by weight) of the chemical is obtained in the solution. The solution is allowed to cool for 4 hours to obtain a homogeneous dispersal of the chemical. The good quality of carboxy methyl cellulose gives transparent solution which is better than dextrine or starch pastes. It has fungi and insect resistance property which can apply with a brush. Once it is dehydrated correctly it does not decompose and retain its properties for over a fortnight.

PRESERVATION OF DOCUMENTS

PREPARATION OF MAIDA AND STARCH PASTE

Maida	1 Part in Weight
Water	6-7 Parts in Weight
Barium Carbonate	3% of Maida
Formalin (40% Solution)	2.5-3%

Requisite quantity of maida or starch is mixed with proportionate water in a aluminium vessel. The mixture is boiled about 30-40 minutes taking care so that no lumps or nodules are formed at the base. The mixture is boiled on fire till it start frothing and simultaneously stickiness of the paste formed. During boiling, paste is kept well stirred so that there may not be any charring of maida at the bottom due to over heating. Barium Carbonate is mixed to it after and the paste is well stirred. Finally requisite quantity of formaline is added and stirred well.

Library building and control of its atmosphere

Library Stack Room : Library generally set up in towers, in place with thick walls and windows, some times in the historic discarded building where there is no healthy condition of library materials or residential building where lavatory is within stack area. Where temperature & humidity fluctuate very high, some where sun rays enter into stack area. In course of time with the advancement of Preservation Science, the concept has been changed for ideal storage area. The following criteria should be maintained in the new library building.

PHYSICAL CONDITION OF PRESERVATION OF LIBRARY RESOURCES

After 1950, a French Archivist Mr. Michel Duchein first attempted to regulate the atmosphere as indicated experience has proved that the optimal conditions for avoiding the

PRESERVATION OF DOCUMENTS

development of fungi on paper are between 50% and 55% relative humidity.

Mrs. Françoise Flider and Mr. Michel Duchéin (published in 1983 by UNESCO) opine that the climate and hygrometric norms to be respected for an optimal preservation of old documents, paper, palm leaf and parchment.

These norms consist of an air temperature of $18^{\circ}\text{C} \pm 2$ and relative humidity between 45% and 50%. These conditions should be maintained 24 hours a day for 12 months a year. These norms are relevant to the good conservation of all documents on paper (books, maps, engravings, painting on paper as well as archives) and thus concern the directions of Library and Museum as well as that of the Archives.

The decision made by the President of the French Republic, on July 14, 1988 to construct the great French Library during his second term of office intended to replace to a certain extent the present National Library prompted experts once again to determine optimal conditions. Eighteen degree centigrade (+ or - 1) with 55% (+ or - 5%) relative humidity must henceforth be maintained throughout the year. In order to maintain an artificial atmosphere in the storage rooms, one must therefore install air-conditioning. As per Mrs. Flider, Director, Centre for Research on the Conservation that the written documents maintains air-conditioning where one can keep optimal conditions in stack areas. Air-conditioning consists of the following parameters: heating or cooling, filtering, humidification or dehumidification and mechanical ventilation of the air. The result is the creation of a constantly controlled, artificial atmosphere in archive storage areas. Air-conditioning requires the rooms to be hermetically closed.

PRESERVATION OF DOCUMENTS

Conservators have realised the complex interdependence of elements important to the conservation documents in good conditions.

- i) The constant temperature and humidity in stack areas.
- ii) The presence of elements likely to perturb this regulation of buildings. Ultraviolet light, condensation, transmission of heat through the walls and windows, the effects of which are directly related to the nature of the construction of the building.
- iii) Fluctuation of temperature and humidity in winter and in summer.
- iv) The homogeneity to these conditions in the entire storage area, an element which implies a satisfactory circulation of air, in order to avoid an area of stagnant air which would risk the development of mould and insects.
- v) The conception is for installations for treating the air and the nature of its component elements.

Since 1985 (Congress of Vienna) the International Council of Archives has been studying the factors which tend to stabilize desirable conditions in archive storage areas. Interesting proposals have been made for reducing and even eliminating these factors.

THE TREATMENT OF THE ATMOSPHERE IN STORAGE ROOMS

The layman has no difficulty to understand the problems caused by the loss of heat through exterior walls and windows. Conservator has thus been particularly concerned in recent years with the coefficient of heat surface transmission K (calculated in walls by square meters by degrees centigrade),

PRESERVATION OF DOCUMENTS

that is to say, with the nature and thickness of the materials composing these walls and windows. Thus the Germans, in the construction of the Archive building in 1971 and Bundesarchiv in Coblenz tried to resolve the problem by the best possible thermionic insulation of the storage areas. The walls are double, more than a meter thick obviously without windows.

The thermal characteristics of archive building can be imposed on architects and builders by an official text. The co-efficient QI (i.e. the volumetric coefficient of heat loss for a difference of temperature of 1°C between inside and outside divided by the volume of the room expressed in watts per cubic meter and in celsius degrees ($W/m^3^{\circ}C$) of new archive buildings should not exceed 0.40. In order to achieve this co-efficient, attempt was made to unite the surface of exterior walls of the storage area, for instance, by placing this area in the middle of the archive library building, and by insulating the walls thoroughly (the most common choice nowadays) in France is a double walls, exterior facing, a vacuum, thermic insulation, then a concentrate wall).

The Library / Archives Storage rooms constructed in France in the ten years tends to meet a certain number of criteria.

- i) A good insulation of the full outer walls.
- ii) Considerable limitation of the surface of walls in contact with the exterior.
- iii) Windows reduced to a strict minimum, (not eliminated entirely as the vast majority of archive directors refuse to accept totally windowless storage rooms).
- iv) Introduction of fresh air reduced to a strict minimum. The introduction of fresh exterior air is in a proportion of 0.5 of the volume of the area per hour.

PRESERVATION OF DOCUMENTS

- v) At later ventilation of the storage areas would make it possible to avoid, at least particularly and possibly totally, this introduction of outer air.
- vi) Mixing air inside the storage areas by air vents place according to the orientation of the shelving. The rate of flow should be greater than that of the introduction of fresh air and should correspond to the flow of the blow fan.

Installation of atmosphere treatment systems generally include the following.

- i) Forced ventilation of which the flow should not be lower than 5 vol. air/hour. The flow of mixed air is then clearly higher than the flow of new air. This flow of mixed air corresponds to the flow of the flow fan.
- ii) A heating of the air, either simply by radiators, or in a more sophisticated fashion in winter, by a hot battery on which the ventilated or blown air passes in the storage area.
- iii) A cooling of the air in summer, which can be effeculated with a cold battery, either by direct depressuring or by a circuit of cold water.
- iv) The dehumidification of new air and mixed air in the summer and in spring and fall by dehumidifiers.

One must always remember to place an air filter in the fresh air vent. Natural air contains many impurities, some coming from natural processes, but most from human activities. This is a particularly urgent problem in big cities. Usually corrugated filters made of fiber glass or synthetic fibers one to 10 thousand of a millimeter thick are used when the atmosphere

PRESERVATION OF DOCUMENTS

of the storage area is created by a system of controlled mechanical ventilation. It is suggested to filter both fresh air and recycle air in order to maintain the cleanliness and therefore the efficacy of the mechanism.

A mechanism to prefilter outside air, incorporated into the pipe of incoming air, may be added to complete the system. It is relatively easy, even for a layman, to calculate how much is needed to heat the air blown into the storage area in winter. The necessary energy must compensate the loss of heat through the walls, and that the new air can be calculated easily based on the notion of unified day degrees provided by the weather stations. The energy calculation for the summer much more complex. There are three elements to take into consideration : temperature, sunshine, and the relative humidity of the air. This calculation must be done by a thermodynamics expert. Dehumidifying the air in the storage areas falls the major problem during summer and spring. It is virtually impossible to maintain a constant temperature of 18°C in summer in India without the use of a complete air-conditioning system as described above. By observing the procedures described above (thermal inertia of outer walls, orientation of the storage area, mixing the air, reduction of the flow of incoming exterior air). It is managed nonetheless to limit temperatures most of the times to 20-23°C with a few peaks of 24-25°C a few days a year. If the relative humidity in the storage area remains around 60-65%, the situation will be favourable to the rapid development of fungus, mould and other micro-organism. In order to avoid such development, even if it is not financially feasible to install a system of dehumidification linked to the air-cooling system. It is recommended to install mobile dehumidifiers in each storage room. It is also recommended to plan an exterior evacuation of condensation, as well as a hygrostat for each dehumidifier,

PRESERVATION OF DOCUMENTS

which will limit functioning to periods when the relative humidity rises above an acceptable level.

Storage area

Library is a growing organisation and as a result collections are increasing continuously. Simultaneously, to upkeep and accommodate the collections, new buildings are required to be built. The following criteria should be maintained in a library and archives storage rooms :

- i) A good insulation of the full outer walls.
- ii) Considerable limitation of the surface of walls in contact with the exterior.
- iii) Window should be reduced to a minimum.
- iv) A better ventilation of the storage areas is needed in order to introduce fresh air.
- v) Mixing air inside the storage areas by air vents placed according to the orientation of the shelving. The rate of flow should be greater than that of the introduction of fresh air and should correspond to the flow of the blow fan. A pedestal fan should be used in between a row of shelves.
- vi) Steel racks should be used instead of wooden one in order to get rid of damage due to insect attack. The newspaper rack should be special quality. Because it is heavy and oblong size. More than two/three volumes should not be kept one after another. This shelves distance should be maintained 6" instead of 14" or 15" in case of books shelves. The rack should be set up at least 9" apart from the wall for airy and inspection of termite attack. False ceiling should be removed from the

PRESERVATION OF DOCUMENTS

stack area. Lavatory should not exist near the stack area.

- vii) The atmospheric treatment systems should be installed as follows :
 - a) Forced ventilation of which the flow should not be lower than 5 volumes of air/hour. The flow of mixed air is then clearly higher than the flow of new air. This flow of mixed air corresponds to the flow of the blow fan.
 - b) Heating of the air, either simple by radiators, or in a more sophisticated fashion in winter, by a hot battery on which the ventilated or blow air passes in the storage area.
 - c) Cooling of the summer air can only be effected with cold battery, either by direct depressuring or by a circuit of cold water;
 - d) Air must contain many impurities. Some are coming from natural processes, but most from human activities. This is particularly an urgent problem in big cities. Corrugated filters made of fibre glass or synthetic fibres one to 10 thousandth of a millimeter thick is required to be used. When the atmosphere of the storage area is created by a system of controlled mechanical ventilation, it is advised to filter both fresh air and recycled air in order to maintain the cleanliness.

PRESERVATION OF DOCUMENTS

DETERIORATION CAUSED BY MACROBIOLOGICAL AGENT AND ITS CONTROL

India is a tropical country with heavy rainfall, high temperature and humidity favourable to the growth and reproduction of insects and fungi almost through out the year except the areas at higher altitudes and in most northern parts of the country have lesser incidence of biological decay. Deterioration also takes place by the living organisms because of their organic constituents which provide a rich source nutrition.

Damage takes place by biological agents is called "Biodeterioration". Biodeterioration may be characterised by Micro-biodeterioration and Macro-biodeterioration. Besides Library materials, there are also other nutritive substance which has been used for restoration of library materials such as paste, straw board, leather, cloth and jute etc. Besides biological causes, the chemicals which are used for manufacturing of paper play predominant role for deterioration of paper. The deterioration of paper depends upon chemical and biological causes, if not maintained properly.

MACRO-BIOLOGICAL AGENT OF DETERIORATION

It is one of the external causes of deterioration of library materials. Insects and rodents are most common Macro-biological agents which caused damage to books. Magnitude of damage due to insect is some what difficult to ascertain even though the damage is more than that caused by rodent.

INSECT

The problem of virulent attack by insects in the National Library Collection has compelled the organisation to take up a project on Ecological, Micro-biological and Entomological

PRESERVATION OF DOCUMENTS

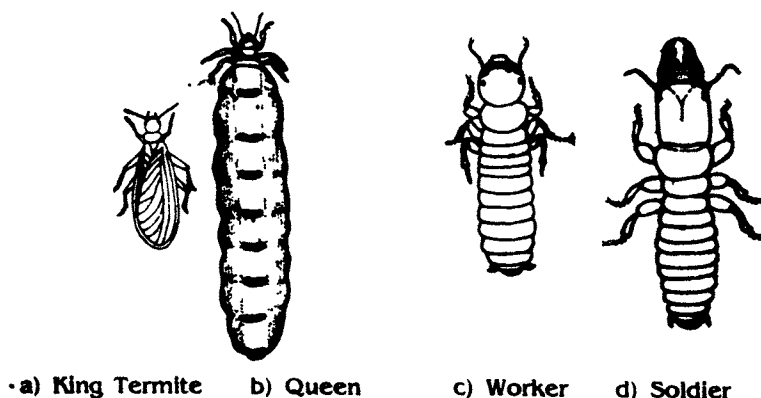
aspect of Library damage. The work has been assigned to the author by the National Library Authority. He started work in collaboration with Calcutta University, Calcutta. He conducted field survey, sampling and other parameters of insect infestation in the Library. He collected various samples of dust from infested books at an interval of 7 days and observed different categories of insects such as Silverfish (*Acrotelca collasts*), Termites (*Isoptera*), Beetle (Anobidae and cleridae family), common cockroach (*Blatta orientalis L*), American cockroach (*Periplaneta americana L*) etc. in the collection.

TERMITE

Termite is a tiny soft bodied most destructive wood or cellulose feeding pest. It is a subterranean insect which called Isoptera due to equal winged. There is no distinct larval or pupal stage. Young termites are similar to the adult except that in the young state they do not have wings. The young termite is called nymph. There are three main types of termites which can easily be identified as adults, workers and soldiers. King (male) and queen (female) are reproductive forms. They have two pairs of wings which are varying in colour from transparent to a light brown colour. The wing size is generally twice as long as the insect body. Workers are white soft bodied measuring about 5 to 6 mm and have no wings. Their thorax is continuous with body and cannot be differentiated. The worker termite has a mandibular and globular head while the soldier termite has a long snout like projection on the head. Worker termites do all the works of the nest. They feed other categories and nymphs. Soldier termites are very rare which has elongated strong head protruded forward larger than the worker. Termites attack wood, leaves, paper paste, board, textile, cloth fibres, leather etc. Worker termites are cannibalistic and eat their own caste, nymph, soldiers. As they

PRESERVATION OF DOCUMENTS

are cannibalistic insect, man have explored contact poisoning which is very easy method to eradicate them. Author observed that the dead worker termite was eaten up by the other as a result of contact poisoning which caused their death also. Mr. O. P. Agarwal 1978 observed that the food is passed from one individual to the other. The food exchange takes place mouth to mouth or anus to mouth. They are fond of only cellulose beside lignin, tani, pectin etc. because they cannot digest easily. They are unable to segregate cellulose from impure lignin, tanin, pectin and they leave it as excreta as a faecal matter. They are more susceptible to new book than old. The tunnel is muddy colour semicircular on the wall 8 to 9 mm wide which is made up of sand, clay mixed with saliva. It follows zig-zag course or straight on the wall. It has been observed that Termites tunnel evolve in moist and humid place. Very often termites get up from the soil or get down from roof's wooden structure in search of food. Generally in the rainy season they extend their run way by the same materials. When the tunnels are broken it is seen that worker cannot tolerate light. They move very slow in the light and withered away very soon. They need damp and moist atmosphere. During rainy season they leave their nest and many of them are eaten up by birds and other insects.

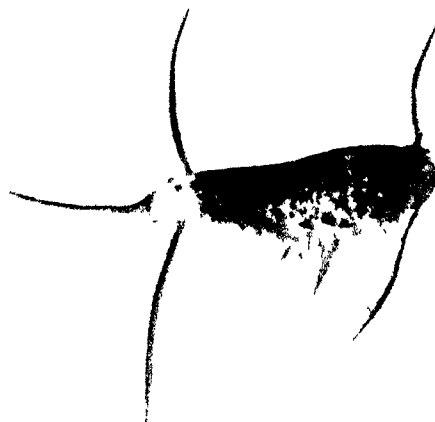


PRESERVATION OF DOCUMENTS

SILVER FISH AND FIREBRAT

The Silverfish (*Acrotelca collata* L) and the firebrat (*Thermobia domestica* Packard) belongs to the order of Thysanura. The silver fish and firebrat are silvery or pearly gray in coloured insects and have no wings. Their body is covered with thin scale which gives it a silvery shiny appearance. It is measuring about 1 cm to 1.5 cm length, 4 mm width at the broadest part. It has three pairs of legs. second pair little bit shorter than the third one. There are total three hairy appendages. Two hairy antennae long on the head and two are likely very short just below it. There are cross sectional mark along the body and both sides are shiny in case of firebrat. Firebrat found in kitchens, backeries and food debris. They were cultured in 1 liter beaker for four months covered with long mesh cloth. Feeding was given with imported lens tissue paper (pⁿ 6.8) 90% alpha cellulose transparent and white. They ate only tissue paper place to place noncontinuous but not at all old book-page aged about 105 years (pⁿ 5, hemp). Author observed that eggs are brownish colour and oval or kidney shaped found in excreta. The eggs are hatched in 16 days and young ones are look like adult. They are most active in night and may be encountered at their work of destruction. Silver fish mostly feeds on surface perhaps due to bulky body. They cannot enter into the books. They are fond of starch, flour-glue and paste. At the Asutosh Collection of National library, author has observed silver fish at the backside of calendar pictures on the wall. They disfigured the miniatures of painting and illustration and manuscripts.

PRESERVATION OF DOCUMENTS



Silver Fish

COLEOPTERA BEETLE

Coleoptera is next severe insect towards the damage of Library materials. Author observed that among the Library pests, beetles are one of the major group of insects, which cause enormous damage to Library collection. These beetle pests pass through eggs, larval, pupal stages, and finally become adult. Beetles comprise the largest order "Coleoptera" of animal kingdom, these include around 25,000 described species and over 600 species have been associated with Library materials (Hinton and Corbett, 1963) of which, some causes direct damage to Library and seeds.

The larvae and adult beetles which the author has got during survey belonging to the family Anobidae and Cleridae in the order Coleopetera. *Thaneroclerus bugueti* Lerevre belonging to Cleridae family. *Lasioderma serricorne* (F), *Stegobium paniceum* belonging to Anobidae family (reported by the Zoological Survey of India, Calcutta).

PRESERVATION OF DOCUMENTS



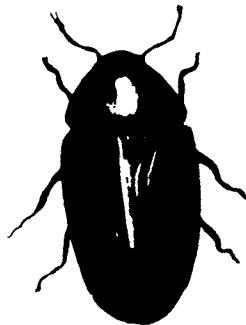
Beetle Pupa

STEGOBIUM PANICEUM (DRUG STORE BEETLE)

In the month of June and July, maximum live insects were caught by the observer. They started whirling in morning nearest to the window of the Annexe Building where Sun light reached first. It settled on the wall, gradually when the Sun goes up further. The *Stegobium paniceum* served in the old books, had a length about 3 to 3.5 mm and width 1 to 1.5 mm. They are of a reddish brown or dark brown colour. Antennae are large and loose, three jointed club. On the wing-cases there is a series of narrow longitudinal grooves, each of which is marked with a row of closely set small pits. The female seeks a place to lay her eggs at a crack or even the space between two boards tightly pressed together, suitable to receive the eggs. She avoids, if possible, laying her eggs on a smooth or exposed surface of the substrata and the eggs are oval, white in colour and about 6mm long. Through out the year larval form was found in almost every collection. Larvae are as like as caterpillar hairy through out the body, red black spotted on the head. Under insectarium condition it remains alive. But when it was exposed to the open surface with food

PRESERVATION OF DOCUMENTS

it died away within 3 to 4 days. At the larval stage mostly they damage the books. It is observed that they make tunnel vertically into the book. The diameter of the tunnel is about 1.2 mm and zig-zag course. Run way is less in the middle portion of book, it might be due to less oxygen.



Stegobium paniceum

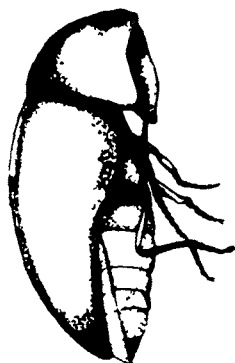
LASIODERMA SERRICORNE (F)

It is a serious pest species on oil cake and stored cereals. Author has observed that they are causing severe damage Library materials and starch, gum, leather, paste which are used for restoration of Library's old collection. Their larvae and adult damage the book which is found abundantly during the months of May and June in the Library according to Collection table Annexure-I.

This species is comparatively smaller than other beetles measuring about 2.3 to 3.5 mm. It can be easily recognised because their head is bent down ward and is oval, reddish yellow to brownish. Antennae joints have 4-10 serrate. Detailed biology has been worked out by Howe (1957) and stated that the females are capable of laying about 100 eggs. Young larvae are very active and capable of penetrating tiny

PRESERVATION OF DOCUMENTS

holes in the books and attack book covers where paste and gum etc. are available. At favourable temperature and humidity larval development takes 17-30 days but may longer in cooler condition. Their pupation period is 3-10 days. Under favourable condition total development from egg to adult takes 6-8 weeks. This beetle breeds in cracks, crevices in stack etc. at temperature above 19°C and above RH of 20-30% but 30-35% and 60-80% R.H. are optimum.



Lasioderma Serricorne (F)

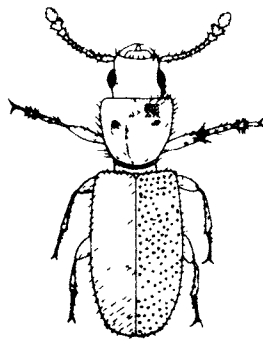
THANEROCLERUS BUGUETI LEREVRE

Thaneroclerus buqueti lerevre is found through out the tropical and sub-tropical countries. In India, the species were found in Pondicherry, recently the author observes in old book in the collection of National Library, Calcutta. In various parts of the world, the species has been recorded in association with grain, old seeds, copra and oil cake, cocoabeans, spices, animal products and sago flour.

This Coleoptera beetle is little bit larger than the furniture beetle, but not so convex. There is, however, considerable variation in size 4 to 5.5mm in length and 1 to 1.5 mm in width. They are dark brown in colour with the wing cases

PRESERVATION OF DOCUMENTS

reddish brown and some what glossy. Their look two joints of the antennae are longer and much stouter than the others, and form a club-like ending. The feet are five jointed and slender, but the first joint is very small and inconspicuous, and the last one, bearing the claws, longer than all other joints together. Author observed *Thaneroclerus buqueti* and *Lasioderma sericorne* attack the small object and remain in association in the same place. *Thaneroclerus* is a serious peste, starch, leather, straw board. This insect is predatory in nature, and destroying the book. It may predate on the larvae of *LASIODERMA SERRICORNE* or some other injurious insects. General emergence of the adults from the book usually begins in May and continuous until July. The larvae of it as like a Caterpillar white colour has cross section and wider head part and gradually narrow towards tail. Its length is about 6 to 7 mm. The duration of life cycle depends upon variation in temperature effect and moisture content of less than 10% in book largely inhibit growth.



Thaneroclerus Bugueti Lerevre

COCKROACH

Two Species of Cockroach are found in India such as common or Oriental Cockroach (*Blatta orientalis*) and American

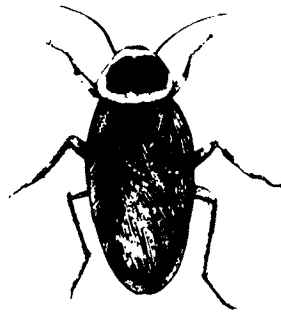
PRESERVATION OF DOCUMENTS

Cockroach (*Periplaneta americana* L).

Blatta orientalis L : The general colour is brown or dark brown. In the male, the wings are developed through the fore wings which are not used in flight, in the female both pairs are reduced to useless vestige. The antennae are as long as the body and many segment. The tegmina of the male are dark brown and cover about two-thirds of the abdomen and wings are of the same length. The abdomen of the female is broader than that of the male. The male have a pair of styles situated between the pair of jointed cerci which project from the rear end of the body. Both the male and female adults are 2 cm long, the female is capable of laying a number of capsules and it contains two rows of eight eggs each. The dimension of each capsule is about 1.2 cm length and .8 cm breadth. The number of capsule has been confirmed by Gould and Deay (1940), who found that one female which lived for 140 days laid nine capsules of which five fertile and from each of which fifteen young emerged from April to September. Since India is a tropical Country, number of capsule of cockroach may increase.

Periplaneta americana L : It is the largest of our domestic species and has fully developed wings whose length is about under 4 cm. It is reddish-brown colour with a light brown and antennae, elytra and wings are all longer than the body. Its eggs capable of similar to that of *Blatta orientalis*. It is learnt that cockroach may live up to about fifteen months and male dies earlier than the female. They do immense damage to book cover. They excrete a dark liquid which discolours any material over which they crawl. Cockroach prefers sweet food but in dispersion attack books, magazines, paper boxes, adhesives etc. Common people have seen it in the kitchen room where temperature is high and their characteristic is known to all.

PRESERVATION OF DOCUMENTS



Cockroach (*Periplaneta Americana* L)

RODENTS (Rats, Mice, Mole)

Rodents are one of the Library's and Museum's enemies found all over the world. Rats carry diseases and destroy cultural property. In this library they eat anything made of paper, leather, vellum, glue, paste, gelatin etc. It has been observed that rats or moles move frequently under ground of the Library. They come up in the stack area in the evening in search of food. The Library personnel use to keep their tiffin in the drawer or cup board as a result they are tempted. National Library has an open shelf system generally they nibble the backs and covers of both leather and cloth bound volumes. Rats are fond of spawn, coconut oil, meat etc.

It is observed from Data Table that higher the acidity in paper lower the insect to affinity to attack of the book when new paper contains above pH 5.5 and at this stage insect attack the material, but as it gets brittle due to gradual accumulation of acidity upto pH 4.4 (from different sources) and insect restrain to attack. It has been observed that heavily insect damage old books have no abundance of insect. They might

PRESERVATION OF DOCUMENTS

have migrated to other bound volumes or new books where abundant of nutritive food is available. Insects attack book covers and spine where flour paste gum, starch and other adhesives are available for their food. Insects density gradually come down from November to March and increases May to July.

CONTROL MEASURE OF INSECT AND RODENT

During the survey of this Library. It has been observed that natural control is the best method to control the insect without using chemical. Environment of the Library is responsible for attack of insect. Stack area is the breeding ground of insects due to the collection of book-dust and some larvae, pupa and young insects moving inside the books. When they become adults they go out of the open doors and windows to the light areas in the morning. The adult insects migrate nearest to the Library building where turf and grass are present in the soil. The soil of the Library surroundings was tested, analysed, correlated with the insects population of this Library. The Library surrounding must, therefore, be kept clean and paved with gravel stone.

The insects and rodents which damage library resources have been controlled by using insecticide & rodenticides.

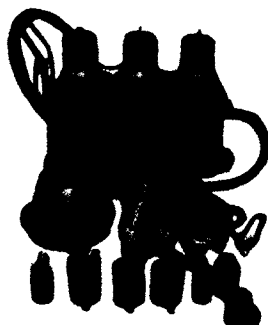
Three different processes of disinfection have been adopted by the National Library such as Contact poison, Stomach poison and Respiratory poison.

Contact Poison : These poisons which kill the insects only by touch are Pyrethrum, Malathion, Dichloroovoj. Benzene hexachloride.

It is not possible to control insects in Library collection without air condition of the Stack. As a control measure,

PRESERVATION OF DOCUMENTS

insecticides spray should be done on books through different equipments at an interval of 3 to 4 months because the life span of almost all insects are about 3 to 4 months. Pip insecticide has been used in the National Library for controlling insects since long back. It is a compound of Pyrethrum 2%, petrolium extract and perfume which has no residual effect on paper and no side effect on human body. This chemical is quarterly sprayed by Euroclean Machine on Library collection, it destroys cold blooded insects inside the books effectively. It can also controlled termites.



Tri and Mono vacuum clener, Fumax and sprayes

2. Stomach poison : These poisons kill the insects and rodents easily where insecticides are eaten up by the insects & rodents through food or baits. Arsenic Trioxide, Barium Carbonate, Zinc phosphide are used as rodent (rats : mice, mole) control. Rodents are one of the Library's and Museum's enemies found all over the World.
3. Respiratory Poison : The fumes of these insecticides which enter the body of insects through respiratory openings during inspiration and directly affect the lung. Respiratory poisons are Carbon disulphide and Carbondioxide and Ethylene oxide,

PRESERVATION OF DOCUMENTS

(1 : 9) Para-dichlorobenzene etc. substances which have been used for restoration of Library materials such as paste, straw board, leather, cloth and jute which are susceptible. Besides biological agents, the Chemicals which are used for manufacturing of paper play a predominant role for deterioration of paper. The deterioration of paper depends upon chemical and biological causes, if not maintained properly. Different fumigation processes have been discussed in this chapter.

FUMIGATION CHAMBER

Fumigation chamber is as well as steel almirah (6'x3'x2') with air tight single door. It has rubber gasket arrangement for air tight with five shelves which 1" dia perforation at distance of four inch where books are shelved.

Fumigation with the Para-dicholobenzene is one of the conventional fumigants for disinfection of Library materials. This is very easy and of course long term process which can be adopted in any size of the Library. 50 gms. paradicholorobenzene per cubic foot for 21 days is quite effective for disinfection of Library materials. Within the first week, life insects are destroyed and at the end of second week eggs are hatched out and becomes larvae which are destroyed within third week. The chemical is kept at the bottom shelves in a tray which is volatile pass through perforated shelves and penetrate it into inverted book which are arranged in the shelves.

PRESERVATION OF DOCUMENTS



Fumigation Chamber

VACUUM FUMIGATION CHAMBER

Vacuum fumigation is a modern technique of disinfection of library materials which is essential in a tropical country like India. In this process, poisonous fumes enter into an evacuated high pressure proof steel chamber through volatilizer. The poisonous fumes enter the body of insects through spiracle. Ostium and other opening of the insect during inspiration and directly affect the respiration system.

MANUAL OF VACUUM FUMIGATION CHAMBER

- 1) Requisition of the material for Fumigation
- 2) Loading of the Vacuum Fumigation Chamber
- 3) Tightning of the door of Vacuum Fumigation Chamber
- 4) Operation of Vacuum Chamber

PRESERVATION OF DOCUMENTS

- a) Gas introduction
 - b) Vacuum release
 - c) Fumigant Etoxide - $1 : 9 \begin{array}{c} \text{CH}_2 \\ \text{CH}_2 \end{array} > 0 : \text{CO}_2$
 - d) Air washing
- 5) Open the door of the Vacuum Fumigation Chamber
 - 6) Unload of the chamber.
1. REQUISITION OF THE MATERIAL FROM DIFFERENT DIVISIONS
 2. LOADING INSTRUCTIONS
 - a) To maintain the Book Movement Register
 - b) To arrange the books into the trolley according to the serial No. (Call Number).
 - c) To carry the Trolley from collection spot to operation chamber.
 - d) To clean the Library material perfectly with cleaner.
 - e) Introduce the loaded Trolley into the chamber.
 3. TIGHTENING THE DOOR OF THE VACUUM CHAMBER
 - a) Examine the gasket whether the grease is required or not.
 - b) Tight uniformly all the nuts of the door. Don't tight a single nut at a time.
 4. OPERATION OF VACUUM FUMIGATION CHAMBER
 - i) Before switch on the vacuum pump, close the door properly. Open the valve No. (14) for water flowing through the vacuum pump. Open partially all 4 oil cocks for circulation through the pump.
 - ii) Close all the valves except valve No. (14) water.

PRESERVATION OF DOCUMENTS

- iii) Switch on the Pump and Vacuum Recorder, Open the valve No. (9) oil. After a few seconds open valve No. (7). As soon as the vacuum comes at 28" of Hg.
- iv) Don't open the valve No. (9) when chamber is in vacuum.
- v) Close all the oil valves in the vacuum pump as soon as the vacuum gauge comes to "O".
- vi) Switch on the heater of the volatalizer and allow the temperature to rise as per your requirement. (It should preferably be started before operation of the vacuum pump to 45° - 50°C.
- vii) Introduce the gas through the gas inlet line and open slowly the valve No.
- | | | | | |
|--------|--------|--------|--------|-----------------------|
| (13) A | (13) B | (13) C | (13) D | (13) E |
| 1st | 2nd | 3rd | 4th | Gas Cylinder key last |
- During the period of closing : close the valve in the reverse way gas cylinder as opening time such
- | | | | | | |
|----|--------|--------|--------|--------|--------|
| as | (13) E | (13) D | (13) C | (13) B | (13) A |
| | 1st | 2nd | 3rd | 4th | last |
- viii) For releasing the vacuum open the valve No. (8) & then No. (7). As soon as the vacuum comes to "O" at vacuum reader close the valve No. (8) & open the valve No. (10) Blower. Switch on the blower and seen for about 5/10 minutes for outlet of the fumes and gases from the chamber and then open the door, keeping the blower on four to five minutes more. (For every one or Two operations use the vacuum grease on the door gasket) For checking up the leakage water can be added on the surface of the gasket.

PRESERVATION OF DOCUMENTS

- ix) At the time of operation of the vacuum pump if power falls, close the valve No. (9) as quickly as possible
 - x) Set the pressure control gauge according to the pressure flowing through the pipe from the gas cylinder.
5. Open the door of the Vacuum Fumigation Chamber. During opening the door, all nuts should lose simultaneously.
 6. Unload the Trolley from the chamber.

EXPERIMENT



Vacuum Fumigation Chamber

Silver fish, book worm, book lice and their eggs etc. were taken in a thick cloth packet. The cloth packet was put inside a book kept in the fan-wise position in the sterilizer. The concentration of ethylene oxide and carbondioxide mixture experimented were 16, 18, 20, 22 and 24 gm/m³ which

PRESERVATION OF DOCUMENTS

corresponded to 1952, 2196, 2440, 2684 and 2928 gms of the gas respectively. The time of exposure for each concentration of gas mixture was 3, 4, 5 and 6 hours. The amount of gas mixture needed to maintain a particular concentration was calculated from the formula given by Philips (1949).

RESULTS

The observations are summarised as follows :
Concentrations of the gas mixture and different exposure times are given in table 1.

TABLE 1

Insect mortality rate (%) in vacuum fumigation chamber at 31° C

Ethylene Oxide (CH ₂) ₂ O Dose	TIME			
	3hrs	4hrs	5hrs	6hrs
16 gm/m ³	60%	70%	85%	95%
18 gm/m ³	70%	80%	94%	100%
20 gm/m ³	85%	90%	100%	100%
22 gm/m ³	100%	100%	100%	100%
24 gm/m ³	100%	100%	100%	100%

The observations are summarised as follows :

- With a 3 hr of exposure period for 16, 18, 22 and 24gm/m³ of C₂H₄O doses in vacuum fumigation chamber (12.2 cubic meter) the mortality was 60, 70, 85, 100 and 100% respectively and rest of the insects were in restless stage. The premature eggs were damaged and the matured eggs persisted under these doses in given exposure.

PRESERVATION OF DOCUMENTS

- b) In case of 4 hours exposure, for the same above mentioned doses, the mortality rate was 70, 80 and 90, 100 and 100% as shown in Table 1. The premature eggs were damaged whereas the mature eggs persisted.

Dose at the rate of 22gm/m^3 $\text{C}_2\text{H}_4\text{O}$ within same time of exposure showed 100% mortality.

- c) In case of 5 hours exposure at 16gm/m^3 $\text{C}_2\text{H}_4\text{O}$ dose 85% insects were killed and remaining were restless, 15% insects were reluctant to feed. Premature eggs were found ruptured. Dose at the rate of 18gm/m^3 $\text{C}_2\text{H}_4\text{O}$ for the same time of exposure resulted in 95% insects mortality. Premature eggs were damaged and nature eggs remained in diapause condition.

Dose rate of 20, 22 and 24gm/m^3 $\text{C}_2\text{H}_4\text{O}$ for same time of exposure and in the same sterilizer space resulted in 100% killing of insects and eggs.

Dose at rate of 16gm/m^3 , 20 gm/m^3 , 22gm/m^3 , 24gm/m^3 of $\text{C}_2\text{H}_4\text{O}$ for 6 hours of exposure showed 95% killing for 16gm/m^3 of dose and 100% mortality for rest of the doses. The premature eggs burst out and mature eggs may be in diapause condition.

It is considered the dose 22 gm/m^3 at 31°C for 5 hours exposure to be the most effective dose; respiratory organs like spiracle, ostium located on the body remain open, due to high vacuum pressure inside the sterilizer at about 28, P.S.I.A. At this moment, toxic gas is discharged into the chamber. The insect inhales the toxic gas which causes instantaneous death. The premature eggs burst out instantaneously and mature eggs may become impotent due to the penetration of toxic gas or may remain in diapause condition. However, their hatching are

PRESERVATION OF DOCUMENTS

yet to be studied.

In case of destruction of fungus, exposure time and temperature are required higher than the time period taken to kill the insects and eggs.

In general, no spore forming bacteria are killed with short exposure while a longer exposure is required for 100% kill of spore forming bacteria. Frazer G. Poole (1971) observed (Library Congress Washington 1971 April) that comparatively high dose is required to destroy the bacterial infection than insect infestation. Higher the concentration of ethylene oxide, shorter the time of exposure required for sterilization. Usually doubling the concentration reduces the exposure time by one half. While sterilization can be effected with ethylene oxide at 21.1°C rather long exposure period are required. As temperature is raised the rate of sterilization is increased generally for every 16.6°C rise temperature, the time required for sterilization is half.

ECONOMICS

Use of para-dicholobenzene as fumigant for disinfection is an age old practice for preservation of library and archival materials. 2.3 kg. para-dichlorobenzene is sufficient for operation of two cycles of fumigation for 100 standard size of books and time of exposure for one cycle of operation is 21 days. The cost of chemical involved presently is Rs. 50 for disinfection of 100 standard size books which proportionately comes to 50 paise for preservation of one book.

Total chemical involved per cycle of operation is 3490 gms. The cost of ethylene oxide and carbondioxide mixture has been estimated at Rs. 240/- for 1800 standard size books. Proportionately expenditure when calculated has been found

PRESERVATION OF DOCUMENTS

that the cost comes to 13 paise for disinfection of one book.

Paradichlorobenzene is used in cases of sterilizing insect only. But mixture of ethylene oxide and carbondioxide sterilizes both insect and fungus. So it may worthwhile to mention that vacuum fumigation chamber is cost effective, quicker and cheaper process of sterilizing the library and archival material now a days.

NITROGEN AND CARBONDIOXIDE GAS CAN BE USED INDIVIDUALLY IN PLACE OF ETHOXIDE GAS

Nitrogen

Nitrogen gas has been used for many years. The normally accepted dose is minimum of 98% nitrogen or a minimum of 2% oxygen (Brokerhof 1989). Long exposure periods are required for doing disinfection. Successful fumigation have been undertaken in gas fumigation chambers, but such chambers are expensive.

Carbondioxide (CO₂)

Carbon dioxide has been used as a fumigant to control insects in stored grain for at least 70 years (Baily 1955). It is known that the Romans and Egyptians inadvertently utilised the preservation properties of CO₂ when they stored grain in air-tight pits. Grain respiration eventually raised CO₂ levels and depleted O₂ levels to create a lethal atmosphere (Ordish 1979). More recently CO₂ from pressurised cylinders, from "dry ice" or from fuel burners has been added to grain bins. The use of CO₂ in conventional fumigation of shelved commodities has been problematic because of the need to retain relatively high concentrations of CO₂ is for relatively long periods (Banks, 1979). However, successful fumigations

PRESERVATION OF DOCUMENTS

have been carried out using carefully sealed sheets tailor-made for stacks of commodities (Annis and Graver, 1985). The fumigation "bubble" (Smith 1988) is a gas-tight enclosure available as a portable or permanent structure of virtually any size. The standard size is 30m³.

Any gas can be used as fumigant for disinfection of insects which is more effective in case of vacuum fumigation operation. A suitable fumigant should be selected according to feasibility of operation. The dose is given below indicates the concentration of the fumigants and the period of fumigation required in each case :

Fumigant	Cmc per 1000 cubic feet	period
Thymol	1 kgs.	8 days
Paradichloro benzene	6 kgs.	21 days
Ethylene chloride/ Carbon tetrachloride	6 kgs.	24 hours
Ethylene Oxide & carbondioxide	24gm/m ³ (1:9)	6 hours
Methyl Bromide	1 kg.	24 hours
Hydrocyanic acid gas	500 gms of sodium cyanide/288 c.c. of liquid HCN	24 hours
Carbondisulphide	3 kgs.	24 hours
Formaldehyde	250/cubic metre	24 hours
Nitrogen	98% + 2% (oxygen)	15 days
Carbon dioxide	5%	15 days

RODENT CONTROL

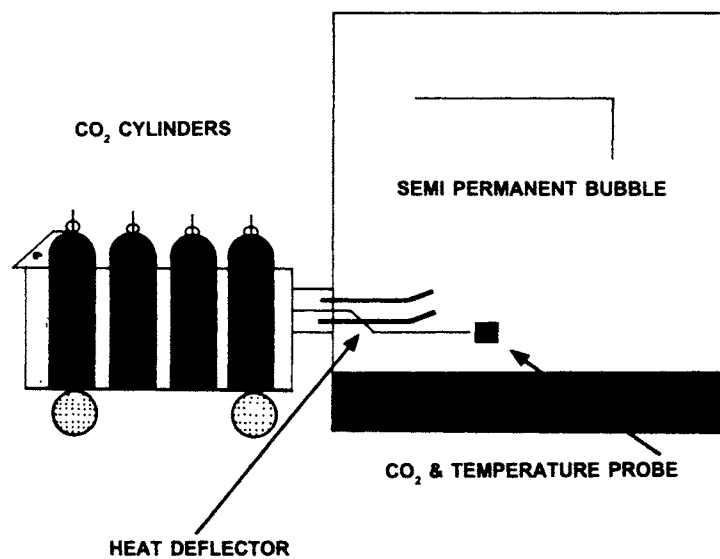
1. By old practice, using various sizes & shapes of traps.

PRESERVATION OF DOCUMENTS

2. Place a layer of caustic soda on the floor near their haunts. Rats running on this layer of caustic soda will make their feet sore and after that they will lick of the feet which will also make this tongue sore.
3. Zinc phosphate (Zn_3PO_2). Barium carbonate (Ba_2CO_3), Arsenic Trioxide (As_2O_3) can be used with rats food which they voraciously eat.

PRECAUTION

Technician of insecticides and fungicides should keep in mind that the books are for user. Insecticides should not be sprayed in presence of the reader. Insecticides should be treated with care although these have no residual effect on paper. Immediately after spraying chemical, one should drink water sufficiently.



Carbondioxide Fumigation System.

CORRELATION OF INSECT POPULATION WITH ACIDITY IN DIFFERENT SOURCE OF PAPER
PULP

DATA TABLE OF DAMAGE I
(Acidity and Insects)

Date of collection	Dimension of book cm	Ins L	I A	Ins L	2 A	Place of publication	Year of publication	Damage	PH	Folding St.	Tensile St. in kg	Pulp	Thickness in mm
5.1.88	24x15x2	2	3	—	—	London	1905	Covers only	4.6	0	.85	Wood straw	.08
4.2.88	18x12x2	0	6	0	1	India	1950	All through Severe	5.4	2	1.3	Straw	0.9
22.3.88	25x15x2	0	2	0	2	India	1921	Damage	5.3	2	3.5	Wood	.13
12.4.88	26x19x1.5	0	1	0	0	India	1803	No damage	5.3	0	.74	Wood	.12
15.6.88	21x5x14x4	0	4	0	0	London	1884	Both sides a few pages	5.0	1	1	Wood	.14
29.7.88	19x11.5x5	0	2	0	0	Paris	1819	All through	5.5	30	2.14	Cotton Hemp	.09
28.7.88	22x13.5x3	0	1	0	0	London	1820	Covers only	5.1	5	1.9	Pag	.08
2.8.88	16x10x2	0	3	0	0	London	1771	All through	5.5	41	2	Cotton	.1
16.9.88	25x15x7	0	0	0	0	London	1892	No damage	5.5	0	.5	Wood	.09
23.9.88	22x14x4	0	1	0	0	Paris	1872	All through	5.5	60	4.5	Cotton	.1
3.10.83	24x16x4	0	0	0	0	Paris	1892	Very little damage	4.4	0	.3	Straw	.1
3.10.88	18x13x3	0	0	0	0	U.S.A	1988	No damage	5.4	1	.4	Hemp	.05
3.10.88	21x14x2	0	0	0	0	Colombo	1870	Heavy damage	5.2	5	1.5	Wood & Spartograss	.12
21.11.88	24x16x3.5	0	0	0	0	London	1844	No damage	4.5	0	.8	Hemp	.12
22.12.88	26x18x5	0	2	0	1	India	1889	All through	6.0	15	3	Pag	.13

175

PRESERVATION OF DOCUMENTS

**DETERIORATION CAUSED BY MICRO-BIOLOGICAL AGENT
AND ITS CONTROL**

The deterioration of Library materials is caused by living organism because of their organic contents which provide a rich source of nutrition for these organism. The deterioration brought about by biological agents is generally referred to as "Biodeterioration". The biodeterioration acceleration is characterised by the fluctuation of temperature (17°C - 45°C) and humidity (45% - 90% RH) because India is a tropical country. Such climatic conditions are very favourable for the growth and multiplication of biological agents of deterioration.

Besides, different qualities of paper, and other material used for binding such as cardboard, leather or cloth and rexins, glue, etc. all of which add to the nutritive content of the books. Because of its cellulosic composition, paper is susceptible to wide range of biological attacks. Moreover, the raw materials and chemicals that go into the composition of paper also play a pre-dominant role in the deterioration of paper, thereby minimising the durability. The micro biological agents of deterioration of paper are bacteria, fungi, of course, bacteria are of much less importance, though certain species of aerobic bacteria may be involved in the deterioration of paper. One of the factors causing on different grades of paper is the sizing. Starch and gelatin which are used in sizing rag, paper and are easily assimilated by fungi. A characteristic rusty brown spotted discolouration of paper is said to be associated with fungus growth. Beck *et-al* (1940) observed that foxing or brown spotting of paper is associated at least partly with fungus growth but point out that it may also be due to the presence of iron. According to him the organic acids secreted by the fungi in course of their metabolic processes react with the traces of iron present in paper forming the iron

PRESERVATION OF DOCUMENTS

hydroxide and ironoxide in paper.

Frugal Fungi Facts.

Air always contains thousands of fungi spores or conidia, in a metabolically inactive reversible rest period which enables them to survive an adverse environmental conditions.

When spores fall on wet materials, the majority of spores do not germinate. They need, in addition to water, a physical or chemical activator. This is why all damp surfaces are not covered with fungi growth after a rain or dew. If a spore is activated but dries up, it will remain activated as soon as conducive environment conditions arise the spore germinates. This is important information to conservators, because many of the chemicals used in treatments such as alcohols, acetone, surfactants, and detergents act as activators. Acid and alkaline treatments also cause activation.

Even ethylene glycol, which is a by-product of ethylene oxide fumigation, activates fungi spores. It is probably the presence of this spore activator in fumigated parchments which appears to make them more prone to support fungi growth.

Fungi are often thought to be xerophyllic, able to germinate under low water condition. Relatively to other fungi, some may be xerophyllic, but the moisture level in materials required for growth is always high. The so called xerophyllic fungi have glycols in their cell which have a lower water activity and then most fungi can tolerate, but still it is high. Generally speaking, it is equivalent to the equilibrium moisture content of absorbent materials held at 80% RH at room temperature. With a view to identify the fungi in different places of the National Library, a survey was launched in collaboration with Calcutta University. Two hundred fungus affected books were collected and tested at the Calcutta University.

PRESERVATION OF DOCUMENTS

Deteriorated portions of the books and periodicals were scrapped out by sterilising forcep and collected in different sterilised petridishes. Each sample was opened with precautions to avoid contamination of the sample and twenty five millilitres of sterilised Emerson Ypss after (Difec) for thermophilic (Cooney and Emerson, 1964) and Czapek's agar medium for mesophilic fungi (*Onion et-al*, 1981), supplimented with trace element solution 0.02 of μg of Mn Per ml for $\text{Mn cl}_2 \cdot 4\text{H}_2\text{O}$;

- 2.0 μg of Zn per ml. from $\text{Znso}_4 \cdot 7\text{H}_2\text{O}$;
- 0.1 μg of Cu per ml. from $\text{Cuso}_4 \cdot 5\text{H}_2\text{O}$;
- 0.2 μg of Fe per ml. from $5\text{cl}_3 \cdot 6\text{H}_2\text{O}$;
- 0.02 μg of Mo per ml. from $(\text{NH}_4)_6 \text{6MO}_7 \cdot 0_{24} \cdot 4\text{H}_2\text{O}_2$
- 0.01 μg of B per ml. from H_3BO_3

were poured a septically into the sterilized petridishes. Samples were mixed with the moltan agar and the plates were rapidly cooled at room temperature. The plates were incubated at $25^\circ + 1^\circ\text{C}$ and $45^\circ - 1^\circ\text{C}$ for mesophilic and thermophilic fungi respectively. Plates were examined at 24-H intervals for 15 days and irregularly thereafter. Colonies were transferred to fresh plates of original medium and incubated.

Observation

Among mesophiles, *Aspergillus niger*, *A flavus*, *sulphureus*, *A. nidulans*, *A. fumigatus*, *Aspergillus. s. P. Bertutis sp.*, *Drachslera tetramera*, *Fusarium exysporum*, *Nicgrospors Sp.* and unidentified species were isolated from the collections of National Library.

Among these isolates *Aspergillus niger* was found more dominant followed by *Aspergillus flavus* and *Aspergillus fumigatus*. *Absidia corymbifera*, *Aspergillus fumigatus*, *Chaetomium thermophile*, *Sporotrichum Thermophile* and

PRESERVATION OF DOCUMENTS

Thermoaseum aurantiacus were isolated among thermophilic fungi.

The fungus affected spots were tested and pH was observed 4.5 to 5.5 whereas unaffected portion, the pH was 5.5 to 6.5. Tensile and folding strength of the fungus affected spots were tested and found low in comparison to other portions of the books.

The mesophilic fungi exhibited substantial capacity to degrade hand made paper indicating cellulolytic nature. Deterioration of the hand made paper was more in 30 days. 11.5% loss of hand made paper was observed in *Aspergillus niger*, *Aspergillus fumigatus* (10%), *A. Sulphureus* (9.5%), *Aspergillus flavus* (7.9%), *Fusarium Oxysporum* (7%) unidentified (8.5%) as compared to control where no loss in hand made paper was observed. Mustafee (1971) reported a greater deterioration of Ramie fibre by *Aspergillus* sp. Among thermophiles, *Chaetromium thermophile*, *sporotrichum thermophile*, *Aspergillus fumigatus* etc. which degraded hand made paper to an appreciable extent.

CONTROL OF MOULD FUNGUS

Regular cleaning and humidity controlling agents like Silica gel should be used to the Library materials to prevent the fungi.

Leather preservative mixture treatment needs to the leather bound volumes to control fungi.

Foxing gives brown spot on the paper. Such type of stains can be bleached by weak solution of Hydrogen peroxide or Potassium permanganate solution followed by weak Oxalic acid solution.

Sterilization of the atmosphere of the storage room by spraying 10% thymol in alcohol or methanol has been recommended to

PRESERVATION OF DOCUMENTS

keep a check on the growth of spores present in stack room where humidity cannot be brought lower than 75% during monsoons.

STERILIZATION OF MATERIALS

Two methods are available for sterilization : Fumigation which is effective but confers no lasting protection, and a method involving the use of blotting papers impregnated with fungicide of low vapour pressure which acts continuous protection over a period.

(i) Fumigation with thymol vapour : one inch thick wooden chamber, 5 feet height, 4 feet breadth and 2 feet width air tight having three shelves' separating by one foot distance. The wooden shelves are perforated of about four inches wide. The hole is about one inch diameter. A horizontal wooden box is kept at the bottom which contain 10 gms thymol in a porcelin basin. 40 watt electric lamp is fixed near the bottom of the cupboard. This lamp emits enough heat to melt the thymol crystals which are placed some 2 inches above it in a clock glass or enamel plate, supported on a wire stand. About 30 gms of thymol is required for sterilizing the contents of a cupboard of 16 cubic ft. capacity.

To use the apparatus, the current is switched on for two hours. The heating should be carried on for periods of about two hours of every morning for fourteen days. If much material is being dealt with, the papers should be rearranged in the cupboard each morning before the light is switched on. After each treatment, the door of the cupboard should be kept closed for about twenty four hours. In stacking the cupboard, it is important to arrange for free access of the Thymol vapour around the infected material, small

PRESERVATION OF DOCUMENTS

manuscripts, may be suspended, rolls set up on the edge, books stood pages open fan-wise.



Thymol Chamber

The method is safely applied to prints, drawing, manuscripts, pastels, water-colour painting books and also to parchment and vellum. No harm has been found to prolonged dosage.

Use of impregnated paper/wet cotton : White blotting paper is wetted by immersing it for a moment with 10 percent solution of thymol in acetone, after which the excess of solvent is allowed to evaporate, leaving the thymol uniformly dispersed in the sheets with a higher but less uniform concentration of thymol by scattering a handful of thymol crystals between several layers of absorbent paper and meeting the crystals into the tissue by the application of hot electric iron.

PRESERVATION OF DOCUMENTS

Thymolized papers, prepared by one or other process, are used for sterilizing papyrus after it has been unrolled or for inter leaving mildowed books.

Lavatory must be set up out side the stack area to avoid the growth of fungi.

It was observed that a few types of fungi can tolerate surprisingly high concentration of certain fungicides which will inhibit other types of fungi at quite low concentration.

An experiment was carried out 1%, 2%, 3%, 5%, 7%, 10%, 12% thymol in cooked sodium salt of Carboxymethyl Cellulose. The result was that there was 1% and 2% thymol fungus growth after 3 days which came up in different colours such as rose, gray, brown in the petridish, at temperature (20°C - 32°C) and RH (70% to 90%).

At 5% solution, there was very little fungus growth after a week which were of different colours :

At 7% thymol, there were traces of fungus after one month.

At 8% Thymol fungus was not found.

At 11% Thymol fungus was not found.

Probably Aspergillus niger inhibits in low percentage of thymol, whereas they had little effect on certain Pencillium species. Para-nitrophenol was found effective against Pencillium but not against Aspergillus. The implications of such variations in tolerance of poisons is essential to use as many test fungi as possible in carrying out laboratory estimations of toxicity. Para-nitrophenol gives yellow colour on hand made and filter paper and some other documents also. But on the newsprint (ground wood) it does not give colour. Paper do not deteriorate after using the antiseptics.

PRESERVATION OF DOCUMENTS

Wheat flour paste, containing 5% pentachlorophenate, is stained pale yellow-pink. The colour intensity increases with the concentration of the antiseptic. Most of the fungi have been found *Penicillium*, *Aspergillus*, *Alternaria*, *Trichoderma* which are destroyed effectively either by using 10% thymol, or direct application of fungicide on the fungus effected books. The dose of the fungicide is reduced by formalin and thymol effect on the paper was tested, before and after use on the paper. It was found that use of Formalin and Thymol does not change the mechanical strength or colour of paper. Thymol is insoluble in water but soluble in methanol.

β -Naphthol was examined on the different grades of paper which gives colour on oxidation. β -Naphthol remains in the adhesive for a much longer time. Freshly prepared glue, containing upto 1.2% β -Naphthol, is colourless, but after some time yellow colour develops due to oxidation.

The fungicide which is effective at lower dose should be selected, keeping in mind that readers' health should not get effected or library materials should not deteriorate due to excess use of fungicide.

The experiment was conducted on the effectiveness of various fungicides and showed the following results :

- i) Paranitrophenol is effective at 0.4% and above;
- ii) Thymol is effective at 8% and above 10%
- iii) Pentachlorophenol is effective at 0.35% and 0.4%
- iv) Formalin is effective 3% and above
- v) β -Naphthol is effective at the level of 0.25% concentration

National Research Institute of Cultural Properties, Japan uses buffering paper as humidity controlling agent. It is very effective to preserve cultural properties. By combining humidity-buffering paper and Bo-Vinylon gilm is ideal

PRESERVATION OF DOCUMENTS

storage environment because relative humidity can be prepared simply and economically by this method as the situation demands at any time and any where. The advantage of this method is the books and oriental paintings sealed with humidity buffering paper in Bo-Vinylon film can be stored at constant humidity and are safe from dust and air without airconditioning.

PRESERVATION OF DOCUMENTS

PRE-CONSTRUCTIONAL ANTI-TERMITE TREATMENT

Pre-constructional chemical Treatment :- This is a process in which soil treatment is applied to a building during the early stages of its construction.

The Indian Standard 6313 (Part II) 1971 was adopted by the Indian Standard Institute, after the draft finalized by the Building Construction practices sectional committee had been approved by the Civil Engineering Division Council.

Subterranean termites are most susceptible of the termite damage in buildings. They form nest or colonies underground in the soil near ground level in a stump or other suitable piece of timber in a conical or dome-shaped mound. These colonies may persist for many years and as they mature, contain a population running into millions. Chemical barriers which prevent the termite from reaching the super-structure of the building will protect the building and its contents. Treating the soil beneath the building and around the foundation with a soil insecticide is a good preventive measure which is attracting attention throughout the world. The purpose of this treatment is to create a chemical barrier between the ground from where the termites comes and wood-work, cellulosic materials or other contents of the building which may form food for the termites.

SITE PREPARATION

The following factors are given below for guidance in preparing a building site for chemical treatment.

- i) Heavy soils and sloping sites On clays and others heavy soil where penetration is likely to be slow and on sloping sites where run off of the treating solution is

PRESERVATION OF DOCUMENTS

likely to occur, the surface of the soil should be scarified to a depth of at least 75 mm.

- ii) Sandy or porous soils on loose sandy or porous soil where loss of treating solution through piping or excessive percolation, is likely to occur; preliminary moistening to fill the capillary spaces in the soil is recommended.
- iii) Levelling, Excavations and filling - All sub-floor levelling and grading should be completed; all cuttings, trenches and excavations should be completed with backfilling in place; borrowed filling must be free from organic debris and should be well compacted. If this is not done, supplementary treatments should be made to complete the barrier.
- iv) All Concrete Form work, levelling pegs, timber off cuts and other builder's debris should be removed from the area should be treated.

ESSENTIAL REQUIREMENTS FOR BARRIER AND METHOD OF APPLICATION

Condition of Formation :—Barriers shall be completed and continued under the whole of the structure to be protected. All foundations shall be fully surrounded by and in close contact with the barrier of treated soil. Each part of the area treated shall receive the prescribed dosage of chemical.

Time of application Soil treatment should be initiated when foundation trenches and pits are ready to take mass concrete in foundations. Laying of mass concrete should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or when the soil is wet with rain or sub-soil water.

PRESERVATION OF DOCUMENTS

The foregoing method also applies in the case of treatment to the earth surface within the plinth area before laying the sub-grade for the floor. Once formed, treated soil barriers shall not be disturbed.

CHEMICALS AND RATE OF APPLICATION

Mound treatment - If termite mounds are found within the plinth area, these should be destroyed by means of insecticides in the form of water suspension or emulsion which should be poured into the mounds at several places after breaking open the earthen structure and making holes with crow-bars. The quantity to be used will depend upon the size of the mound. For a mound volume of about 1 m³, 4 liters of an emulsion in water is one of the following may be used.

- | | |
|---------------------------|----------------------------|
| a) 5.00 percent DDT | d) 0.25 percent aldrin |
| b) 0.50 percent BHC | e) 0.50 percent heptachlor |
| c) 0.25% percent dieldrin | f) 0.50 percent chlordane |

SOIL TREATMENT

Treating the soil beneath the building and around the foundation with a soil insecticide is a preventive measure. The purpose of the treatment is to create a chemical barrier between the ground from where termites come either from woodwork or from other cellulosic materials in the building. Any one of the following chemicals (conforming to Indian Standard) in water emulsion is effective when applied uniformly over the area to be treated.

Chemical	Concentration by weight, percentage
Dieldrin	0.5
Aldrin	0.5
Heptachlor	0.5
Chlordane	1.0

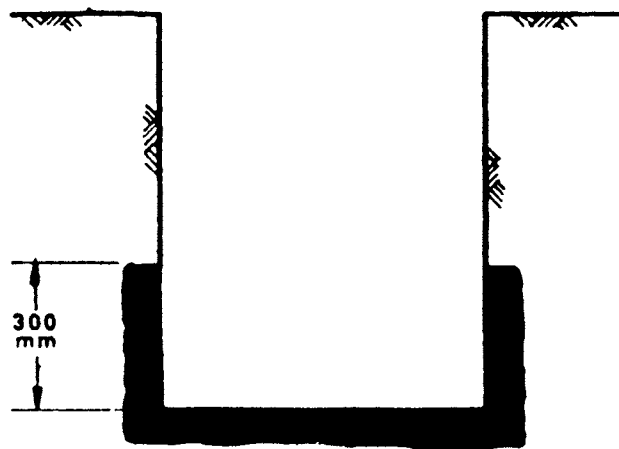
PRESERVATION OF DOCUMENTS

Note : Other chemicals, such as DDT and gamma BHC, may also be used but their effect is not expected to be equally long-lasting under all conditions.

In the event of water logging in the foundation, the water shall be pumped out and the chemical emulsion applied when the soil is absorbent.

Treatment of column pits, Wall Trenches and Basement Excavations.

The bottom surface and the sides (up to a height of about 300 mm) of the excavations made for column pits, wall trenches and basements shall be treated with the chemical at the rate of $51/\text{m}^2$ of surface area (Fig-1)

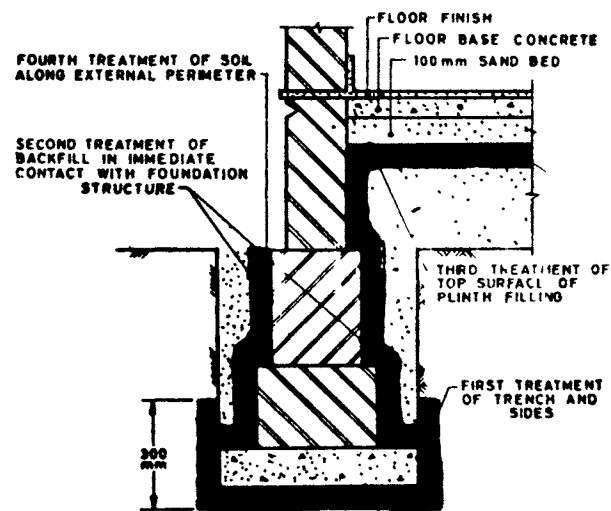


Section

Fig - 1 TREATMENT OF TRENCH BOTTOM AND SIDES

PRESERVATION OF DOCUMENTS

After the column foundations, wall foundations and the retaining walls of the basement come up the back fill in immediate contact with the foundation structure shall be treated at the rate of 151/m² of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical with the above dose. The earth is usually returned in layers and the treatment shall be carried out in similar stage. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the Chemical Fig. 2.



SECTION

FIG-2. TREATMENT FOR LOAD BEARING WALLED STRUCTURE

The treatment described in fig No. 1 applies essentially to

PRESERVATION OF DOCUMENTS

masonry foundations where there are voids in the joints through which termites can seek entry into the superstructure. Hence the foundations require to be completely enveloped by a chemical barrier. In the case of RCC framed structures with columns and plinth beams and RCC basements, the concrete mix is rich and dense (being 1:2:4 or richer), it is unnecessary to start the treatment from the bottom of excavations for columns and plinth beams. The treatment shall start at the depth of 500 mm below ground level. From this depth, the backfill around the columns, beams and RCC basement walls shall be treated the rate of 15l/m² of the vertical surface. The other details of treatment shall be as laid down in Fig-2 & (Fig-3).

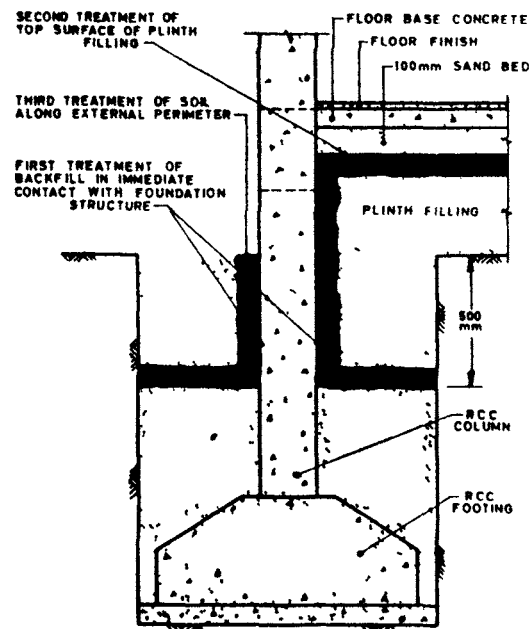


Fig.-3 TREATMENT FOR RCC FRAMED STRUCTURE WITH COLUMNS AND PLINTH BEAMS

PRESERVATION OF DOCUMENTS

Treatment of top surface of plinth filling :- The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of $151/\text{m}^2$ of the surface before the sand bed /rubble soiling or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to deep through, holes up to 50 to 75 mm deep 150 mm centres both ways may be made with crow-bars on the surface to facilitate saturation of the soil with the chemical emulsion treatment at junction of the wall and the floor special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level (where it had stopped with the treatment described in Fig.-2) upto the level of the filled earth surface. To achieve this, a small channel 30x30 mm shall be made at all the junctions of wall and columns with the floor (before laying the sub-grade) and rod holes made in the channel upto the ground level 150 mm apart and the iron rod moved backward and forward to break up the earth and chemical emulsion poured along the channel at the rate of $151/\text{m}^2$ of the vertical wall or column surface so as to soak the soil right to bottom. The soil should be tamped back into place after this operation.

Treatment of Soil along External Perimeter of Building

After the building is complete, provide holes in the soil with iron rods along the external perimeter of the building at intervals of about 150 mm and depth 300 mm and filling these holes with chemical emulsion at the rate of $151/\text{m}^2$ of the perimeter wall.

Treatment of soil surrounding pipes, wastes and conditions :— when pipes, wastes and conduits enter the soil inside the area of the foundations, the soil surrounding the point of entry shall be loosened around each such pipe, waste or conduit for a distance of 150mm and to a depth of 75mm before

PRESERVATION OF DOCUMENTS

treatment is commenced. When they enter the soil to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75mm for a distance of over 300 mm.

Treatment for Expansion Joints :

Expansion joints at ground floor level are one of the biggest hazards for termite infestation. The soil beneath these joints should receive special attention when the treatment under Fig-1 is carried out. This treatment should be supplemented by treating through the expansion joint after the sub-grade has been laid at the rate of 2 litres per linear metre.

PRECAUTIONS FOR HEALTH HAZARDS AND SAFETY MEASURES.

The chemicals described in this code are chlorinated hydrocarbon insecticides with a persistent action and are to be regarded as POISONS. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray, mists or swallowed.

These chemicals are usually brought to the site in the form of emulsifiable concentrates. The containers should be clearly labelled and should be stored carefully so that children and pets cannot get at them. They should be kept securely closed.

Particular care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water specially before eating and smoking. In the event of severe contaminations, clothing should be removed at once and the skin washed with soap and water. If chemicals splash into the eyes they shall be flushed with plenty of soap and water and immediate medical attention should be sought.

PRESERVATION OF DOCUMENTS

The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed during mixing.

Care should be taken in the application of soil toxicants to see that they are not allowed to contaminate wells or springs which serves as sources of drinking water.

PRESERVATION OF DOCUMENTS

POST-CONSTRUCTIONAL ANTI-TERMITE TREATMENT

Inspection : Before undertaking any type of treatment, a thorough inspection shall be made of the infestation in the building with a view to determining the extent to which it has spread, and the routes of entry of the termites into the building. A study of the structure of the foundation and the ground floor helps in finding out the route of entry of termites from the soil and also in deciding the mode of treatment.

Extermination of Termites in Building : After making a study of the infestation in the building, the next step is to be exterminate the termites located inside the building. This operation shall be carried out in a thorough manner, seeking the termites in their hideouts, such as ceilings, behind wooden panellings, inside electrical wiring patterns, conduits, switch boards and similar locations. Recourse shall be taken to inject oil/kerosene base solvents into termite channels in woodwork and masonry followed by sealing openings and spraying the kerosene oil.

Chemical	Concentraion by weight
Dieldrin	0.5 Percent
Aldrin	0.5 Percent
Heptachlor	0.5 Percent
Chlordane	1.0 Percent

TERMITE DETECTION IN BUILDING

A termite control operator must be able to find out whether there are any termites in a building or not. A certain amount of technical knowledge and experience is necessary to determine if there is termite infestation in a building, particularly in the early stages when the attack has just started or it is confined to remote locations in the building.

PRESERVATION OF DOCUMENTS

A bright light is essential for termite inspection. A bright electric bulb protected by a wire-cage and an extension cord would be useful. If this is not available, a flashlight may be used. The operator should also carry with him a pen-knife with a sharp pointed blade to probe into woodwork.

As subterranean termites emerge from the soil to seek entry into a building, the portions of the building in contact with or adjacent to the soil should be the first to be inspected. These would include the basement, ground floor, steps leading from the ground, columns, porches, etc. Locations where there is dampness or where humid conditions prevail, such as bathrooms, lavatories, or other places where there are leaky pipes or drains are likely places of termite infestation. Woodwork at basement or ground floor level, particularly in damp locations, should be examined. The places which demand careful scrutiny are the points where woodwork is embedded. In the floor or in the wall as termites entry through crevices in the concrete or brickwork in which the wooden frames are fixed.

The signs of presence of termites in a building are the tell tale shelter tubes which are termite runways. As termites have soft bodies which cannot withstand the drying effects of air, they move about in sheltered mud tubes which they build when they have to cross open spaces which are exposed to the air. These runways are usually thin and as small as 3mm in diameter. They are therefore, not easily noticed and may go undetected except to the trained eye of an experienced termite control operator.

Termites work inside timber without breaking the surface. They are known to eat away a board completely leaving only the film of paint on the surface. If they break open the surface at any point accidentally, they quickly seal it up, and

PRESERVATION OF DOCUMENTS

their activity continues beneath the surface without detection.

There is nothing as certain as termite runways to establish that infestation exists. However, an operator should be able to distinguish between old runways and new ones. The old runways are brittle and break away easily while the new ones will be moist and stronger. It is not advisable to remove or destroy termite runways during inspection before showing these to the owner or occupant of the building to convince him that there is termite activity in the premises.

If termite activity is noticed in any one location in a building, it becomes necessary to make a thorough search in the entire building. In a multi-storeyed building, if infestation has occurred at the ground floor, all the upper floors must be subjected to thorough scrutiny. There have been instances where termite activity was noticed in one of the upper floors, with no visible signs of attack in the lower floors except perhaps the ground floor. This is explained by the fact that the termites had travelled from floor to floor under cover through lift walls or casings covering electric wiring, telephone cables, utility pipes, etc. Such covered conduits should, therefore, be examined carefully as these are ideal routes for termites. Other places which should be examined are woodwork, wooden panelling on staircases and walls, areas behind picture frames hung on walls, false ceilings, special attention being paid to locations where dampness prevails, such as bathrooms, toilets.

Preventive Measures

Soil treatment : The object of soil treatment is to establish chemical (toxic) barrier between the termites in the soil and the building to be protected. Basically, it consists in treating the soil, adjacent to or under the building with a chemical toxicant which kills or repels termites.

PRESERVATION OF DOCUMENTS

Treatment along outside of foundations : The soil in contact with the foundation along the external perimeter of the building shall be treated with chemical emulsion at the rate of 15 l/m^2 of the vertical surface of the sub-structure of each side. To facilitate this treatment, trenches shall be excavated the width of a shovel exposing the foundation wall surfaces up to a depth of 500 mm and holes 150 mm apart made with an iron rod close to the wall face shall be extended from the bottom of the trench to the top of the footing of the foundation or up to a depth of at least 500mm. Half the total quantity of chemical emulsion shall be poured into these holes and the rest sprayed on the backfill earth as it is returned on to the trench, directing the spray against the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled, as close as possible to the plinth wall about 300mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at a rate of 5 litres per linear metre.

The treatment described in above for masonry foundations. In the case of RCC framed structures, the soil (backfill earth) in contact with the column sides and plinth beams along the external perimeter of the building shall be treated with chemical emulsion at the rate of 15 l/m^2 of the vertical surfaces of the structure. To facilitate this treatment, trenches shall be excavated the width of a shovel exposing the sides of the column and plinth beams up to a depth of 500 mm or up to the bottom of the plinth beam if this level is less than 500 mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench, directing the spray against the concrete surface of the beam or column as the case may be.

PRESERVATION OF DOCUMENTS

Treatment of soil under floors : Chemical treatment should be provided to the soil within the plinth area on the ground floor at the points where the termites are likely to seek entry through the floor. These are cracks at the junction of the floor and walls as a result of shrinkage of concrete, cracks on the floor surface owing to constructional defects and joints in a concrete floor which is cast in section. Twelve-millimeter holes shall be drilled at the junction of floor and walls, along the cracks on the floor and constructional joints mentioned above at intervals of 300 mm to reach the soil below and chemical emulsion squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or up to a maximum of one litre per hole. The holes shall then be sealed properly. In general, the idea is to charge the soil below any openings in the floor with toxicant so that termites in the soil are denied access through these openings.

Treatment to voids in masonry : Termites are known to seek entry into masonry foundations and work their way up through voids in the masonry and enter the building at ground and upper floors. The movement of the termites through the masonry walls may be arrested by drilling holes in the masonry wall at plinth level and squirting chemical emulsion into the bodies to soak the masonry. The holes shall be drilled at an angle of about 45° preferably from both sides of the plinth wall at approximately 300 mm interval and emulsion squirted through these holes to soak the masonry using a hand operated pressure pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at critical points, such as wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal (saturation point) or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

PRESERVATION OF DOCUMENTS

MICROFORMS IN LIBRARIES

Microphotography, popularly called micrography or micrographs constitutes an activity at great importance to our libraries and Information Centres. In the field of information management concerned with creating and utilizing microimage, images too small to be discerned by unaided eye. These microimages are termed as microforms.

In solving the problem involved, micrographic system plays an important role with the help of microfilming, valuable information and the documentation problems are solved not only in science but also rationalisation which largely contributes to augment labour productivity and effectiveness in all fields of economy.

The first experiment in microphotography was made by J. B. Dancer of Manchester in 1839 when he produced the microphotography, and by 1860 the basic problems of making legible images had been solved. In the year 1908, Anandus Johnson working in Royal Archives of Stockholm had an idea of photographing of two legal size documents together on one plate than deciphering the plate with a strong reading glass. In 1914, he developed the first practical microfilm equipment as a direct response to the possible destruction of libraries in the first world war. In May 1926, the Eastman Kodak Company, U.S.A. produced the world's first commercial 16mm microfilm cameras which were installed in two U.S. Banks. Seven years later microfilm spread to Europe and U.K. Micrography as a field in terms of technology and application. This has resulted in three new definitions depending upon how the microform is generated.

PRESERVATION OF DOCUMENTS

One of the conventional source Document Microfilms which is hard copy data recorded into film using basic photographic technology. The hardware could either be planetary or rotary camera.

The second is the Computer Output Microfilm (COM) which is computer generated data (alphanumeric or graphic) being directly recorded into film. This utilises COM recorders and can be done on-line to a host computer or off-line via tape.

The third is optical disk technology or laser technology. Optical disk makes possible the digital recording of large quantities of data, texts, image facsimile and even sound.

TYPES OF MICROFORMS AND THEIR USES

Microform is a generic term. It is the collective name for all the physical formats of microimages containing media.

The term microform comprises with all forms of micro-images. Microforms are available in a wide variety of shape and size, both in roll form and flat sheet form. Within those two broad categories, different formats have now been developed to meet the wide range of applications for which microforms are being used.

There is a wide variety of sizes, shapes and configuration within the physical formats of microforms.

1. Microfiche
2. Roll Film
3. Micro-opaque
4. Aperture Cards
5. Jacket formats

PRESERVATION OF DOCUMENTS

1. MICROFICHE

Most applications in the Archives and Libraries, microphotographs are in two dimensional — array are more practical than micro-film rolls and microfilm strip. Because of their convenient sizes, they can be easily handled and filmed, and mailed in ordinary envelopes. Microfiche can pack a large number of documents in a small format. The title of the documents can easily be indicated photographically on top of the sheet in such a way that it can be readable without any optical aid. Microfiche is a rigid sheet of microfilm of smaller size, different sizes of microfiche are used but sizes 75 x 125 mm, 90 x 120 mm and 105 x 148 mm have the advantage of being the international standard size and mostly used in all libraries.

Depending upon reduction ratio applied on the cameras, the number of rows and columns can vary according to number of formats on fiche. The followings are the international standards on reduction for fiche production :

18.2 x reduction	—	5 rows	—	12 columns	—	60 frames
24.0 x	“	— 7 rows	—	14 “	—	98 “
42.0 x	“	— 13 rows	—	16 “	—	208 “
48.0 x	“	— 15 rows	—	18 “	—	270 “
125.0 x	“	— 40 rows	—	80 “	—	3200 “

While reduction ratios for images on 16 and 45 mm roll film are determined by the kind and condition of the material to be filmed and the maximum size of the image has been specified without regard to the amount of reduction necessary to fit the image into the 10 x 12.5 mm space allotted. An 8.5 x 11 inches document will fit the space easily at 1/24 original size.

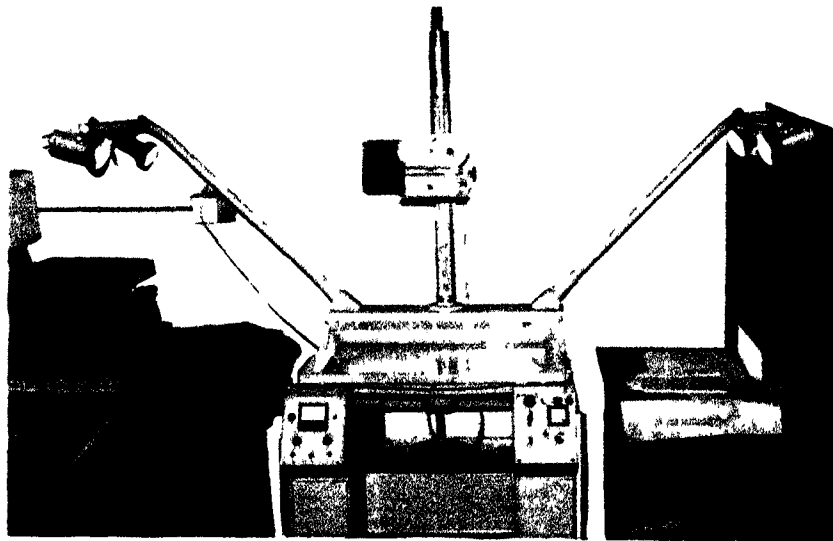
PRESERVATION OF DOCUMENTS

Another non-standard form is the extremely high reductions of microfiche by means of which some 3,000 book pages at about 150 X may be put on one standard size fiche, with such small images the ever present possibilities of scratches in the emulsion represents a serious threat to legibility, so manufacturers have laminated the emulsion size of those ultrahigh reduction fiche to prevent scratching of the emulsion in normal use. Microfiche is generated by using a step and repeat camera which is capable of automatically positioning sequential exposure in a grid format.

Advantages

1. Fiche offer a unit record approach, use of one fiche does not tie up other documents.
2. Fiche to fiche copies are quite economical and can be made easily.
3. They are the only media (outside of special systems) which lend themselves to totally automated retrieval systems.
4. Fiches are easily updated and revised.
5. Fiche is easy and economical to mail, and special packing is not needed.
6. Through the use of microfiche jackets, various sizes of film can be interchanged. This is important when text may accompany large drawings.
7. Secondary distribution is economical.
8. Eye-readable heading of identity individual fiche.
9. When coordinately indexed, specific images can be located with speed.
10. Fiche can be viewed on a variety of economical readers.

PRESERVATION OF DOCUMENTS



Microfilm Camera

2. ROLL FILM

The roll formats are the basic form of microphotographs in linear array. The widths of the films are 16 mm, 35 mm 70 mm and 105 mm. Microfilm rolls may be perforated (i.e., equipped with sprocket rolls) along with one edge or along with both edges. Most microfilm cameras are in use in accept unperforated film as most of the films which are available for the micro-images. Microfilm rolls are normally 30.5 metres in length. The film is round on open reels. The 16 mm film is often housed in plastic cartridges or cassettes. The width of film is selected according to the nature of the documents to be microfilmed. The National Library, Calcutta is generally using Kodak microfilm.

PRESERVATION OF DOCUMENTS

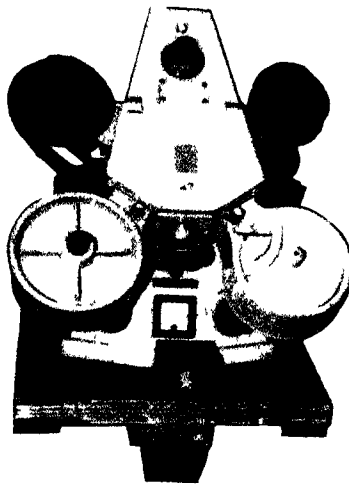
35mm Roll Films

35mm Kodak Film is preferred in the libraries for microfilming newspaper, maps, engineering drawing of two pages newspapers as it is economical at the same time provide bigger size. The deduction factors internationally accepted are between 7.5 x to 29.7 x depending upon the size of original document.

35 mm x 30.5 metres microfilm roll can hold up to 650 full frames and 1,300 half frames. In case, filming of document is done by using the technique 2600 quarter frames and produced on a 30.5 metres microfilm roll. However, the technique of recording depends entirely on the type of cameras and the nature of documents to be filmed. Neither all the microfilm cameras have the provision of half frame and quarter frame nor all the documents could be filmed in these frames.

Roll microfilms are ideal for recording the information on sequential forms which are not up dated frequently. Roll form is suitable for microfilming of old brittle news papers and manuscripts where physical conservation fails, microfilming starts of brittle rare documents and manuscripts. There are two roll film image placements in common use A & B. In the positions A the lines of type run across the width of the film known as cine, where as in the B positions, the lines of the length of the film also known as comic. Roll film format would be simplex and duplex. The National Library, Calcutta is holding four planetary cameras where 35mm film is used.

PRESERVATION OF DOCUMENTS



Microfilm Positive Printer

Advantages

1. Much material is supplied in this format by commercial procedures.
2. A master copy can be produced economically.
3. Secondary distribution is economical.
4. The file is easy to maintain and lends itself to self-service.
5. Containers can be coded to facilitate retrieval from the file and individual reels indexed to speed up searching within.
6. The film, itself, can be coded for very fast retrieval.
7. It can be viewed on a variety of economical readers.
8. Hard copy prints are commonly available on reader-printers now in use in many libraries.
9. It can be shelved with hard copy i.e., on bound journal shelves with or in lieu of the hard copy.

PRESERVATION OF DOCUMENTS

3. MICRO-OPAQUES

A negative is printed to photographic paper rather than to film the paper is called a micro-opaque or sometimes a micro-opaque. The 3 x 5 inches microcard is a micro-opaque. The 3 x 5 inches microcard is a micro-opaque. Another opaque microform is the microprint card. Although these begins as micro film, the microprint Readex Microprint Company. They have an interesting indexing feature in that each card is printed with 100 pages arranged in 10 rows and 10 columns so that it is easy to find any given pages by its location on the card. Special viewers must be used for the micro-opaques since the enlarged image is formed by reflected rather than by transmitted light.

There are several sizes which are identified by their trade names : (1) The Micro Card in 3 x 5 inch sizes (2) The Microprint which measures 6 x 9 inches; (3) The Microlex which is 6-V2 x 8-V2 and (4) The Mini-print at 6 x 9 inches.

Advantages

1. Opaques offer a unit record approach, use of one opaque does tie up other documents.
2. Cards are easy and economical to mail as special packing is not needed.
3. Secondary distribution is economical.

4. APPERTURE CARD

An apperture card is a flat microform. It is a single 35mm frame inserted or stuck to acetate rectangular jacket or aperture or hold provided at the right hand side of a card measuring 187. 25mm x 82.5 mm or app. 7³/₄ x 3¹/₄

PRESERVATION OF DOCUMENTS

inches. The format is very widely used in drawing office application and other areas where it is convenient to record large sized originals on the films which can be handled individually and have visible identification information at the top of card. Aperture cards are delivered ready mounted by some cameras. They can also be produced filming on to 35 mm microfilm roll and mounting the frames individually into cards. In India the later process is commonly used.

Advantages

1. Aperture cards offer a unit record approach, use of one aperture card does not tie up other documents.
2. Secondary distribution is economical.
3. Readable headings identify individual card.
4. Documents are easily updated and revised.
5. Aperture cards are easy and economical to mail and special packing is not needed.
6. The file is machine searchable, although as the size of the file increase, it requires more searching time.
7. Film to film copies are economical.
8. The image size is ideal for large material such as engineering drawings.
9. A variety of economical aperture-card readers are available.
10. Hard copy prints are commonly available on reader-printers now in use in many libraries.

5. JACKETS

An unit stripfilm cut from 16mm and 35mm roll film and inserted transparent jackets made of acetate or mylor. This has been developed from a fiche type format to be

PRESERVATION OF DOCUMENTS

produced from roll film 16mm or 35mm jacket are usually (A6) or 105 x 148mm size for 16mm and 148 x 210mm (A5) for 35 film strip. These consist of two very thin sheets of clear plastic, cemented together at the top and bottom and at intervals of 16 or 35 mm across their width. The space between the cement lines form channels into which strips cut from roll film can be inserted. For reading and print out purposes, jacket can be treated as fiche. Jackets which are suitable for maintaining the office files, medical patient records, personal records and engineering applications. Some new microforms have been developed like fiche aperture cards, colour aperture cards and updateable fiche. The most suitable microform for the reproduction of Archivals and Library materials have been at the present set of technological development roll microfilm and microfiche. Roll microfilm has in fact, become standard for micro-reproduction in Archives and Library. National Library, Calcutta has been using roll microform for micro-reproduction.

Reader printer

Reader-Printers combine the function of a microfilm reader with a device capable of making an enlarged hard copy reproduction from the microfilm image. The printer may be either an integral part of the unit or designed as a modular conversion. Electrostatic reader printers are popular and automatic bi-mode ability which reads the film polarity and changes and print polarity automatically are the new products. Direct transfer of microform to a plain paper.

APPLICATION OF MICROFORMS IN LIBRARIES

When the physical conservation of old brittle rare

PRESERVATION OF DOCUMENTS

documents or manuscripts fails then the micrographics system starts.

The use of micrographics in Libraries was confined to physical conservation until mid 1930s, when micropublishing, a suggestion from the British Scientist J.W.F. Herschel, dating back to 1853, become a reality. Eastman Kodak microfilmed the retrospective files of New York Times for sale to libraries and then by late 1930s, Eugene power founded University Microfilm as a specialised publishing medium. Microforms continue their original role as a medium of Preserving knowledge against possible disasters including floods, fire and warfare and has now taken on new importance as medium to preserve knowledge from print publications which are suffering from deterioration due to instability of the paper, unsuitable storage conditions in the past or present or to high levels of wear and tear.

Application of microphotography in libraries and information centres can be broadly listed below :

1. To develop library collection;
2. To manage library collection;
3. Reproduction and Preservation of library material;
4. As a component in information storage and retrieval systems of varying complexity and
5. To manage the Library's own operating records.

Collection Development

In U.S.A. and Australians Libraries, the collection of microforms is much more than the hard copies. The library is a growing organism, simultaneously number of brittle document or newspaper is increasing which is

PRESERVATION OF DOCUMENTS

needed microfilming for preservation point of view. In 1970, the National Library, Calcutta, started microfilming old Indian newspapers, rare books, Journals, manuscripts, out-of-print materials for readers service. Libraries are unable to get primary source materials and could build up their collection through microforms. Microfilming was also intended to enable libraries and centres of Indian studies in our own country and abroad to acquire copies of these valuable research materials. National Library, Calcutta received microfilm from "Soomprakash" and hard copy was returned to custodian.

Collection Management

Space saving :- Library is a growing organisation as a result every library faces space problem. It is certainly not difficult to demonstrate space saving potential of microforms. About ten square feet in roll microform can accomodate over three hundred square feet of shelf space in printed form. Libraries have tried to replace some of those books, periodicals and newspaper files with microforms in order to save valuable space in the stacks instead of extension of the stack area. Records on microforms need just 4% of the space occupied by the same records on paper.

Microforms vs Building

This approach leads to the management of the periodicals collection which offers two potential advantages back file integrity and economy. Microform back files provide some defence against unavailability resulting from theft or mutilation of paper issues. Because microforms must be used with special equipment that is not widely available outside of the library, microform editions are less likely to be stolen.

PRESERVATION OF DOCUMENTS

In terms of economy, it is important to note that the cost of binding of periodicals of one year will be much higher than the cost of microforms if generated in-house. The cost of duplicate copies will be further much lower, if generated on diazo film.

DUPLICATION

The collection of books and other materials in full size or microform, is duplicated and distributed on demand. Duplication is essential to replace items that are printed or written on badly deteriorating paper, to furnish a working copy of rare and fragile books too delicate for newspapers volumes with a compact form which is easier to use.

3. Microfilming as a Reprographic service : Reproduction of Research materials : National Library, Calcutta wants or needs to create their own microforms which are received as gift, loan from other libraries. The potential, despite the current dominance of the electrostatic copies in interlibrary loan applications microforms remain a viable alternative reproduction of entire books, archival records, manuscript collections, periodical and voluminous research materials. To replace inter-library loan instead of lending, the materials is filmed and the film is sold or given to the borrowing library. The use of microforms can simplify copy handling and significantly reduce both the required time of reproduction and the cost of mailing reproduced materials. A microform use copy may satisfy many research requirements.

INFORMATION RETRIEVAL

Conventional printed materials is slower process than

PRESERVATION OF DOCUMENTS

retrieval of information stored on microforms. National Library, State Library, technical special libraries had adopted retrieval systems utilising microforms as a substitute for printed materials. The simplest retrieval technique for 35mm roll microform utilises eye-legible flash targets with blank frames to separate groups of related microimages on film. The other techniques of retrieval of information are frame numbering indexing, code-line indexing and image-count marks. Now a days, Computer Assisted Retrieval is described as a very fast retrieval device.

The retrieval of information from flat microforms and microfiche requires location of both the appropriate microform and the desired microimage within the microforms. Automated microfiche retrieval and display system are designed to minimise search time of microfiche and frame. The Compact Automas Retrieval and Display (CARD) reader stores upto 750 microfiche in an interior carousel. Each microfiche bears a numerically-coded notched metal clip. The reader itself has two keyboards. To retrieve, a particular microfiche and frame; the user enters the fiche number of the left-hand keyboard and the frame coordinates at the right hand keyboard. The carousel is then to search, the desired fiche located by its average is less than five seconds.

5. **Library Records Management**

Microfilming of card catalogue is the most important application of microforms. As an alternative to the high cost of printed book catalogues, several public and co-operate libraries, microfilmed their union card catalogues; distributing duplicates to members libraries.

PRESERVATION OF DOCUMENTS

The acquiring of microforms materials is intended to answer several of these purpose, even in the case of a single, microfilm copies of periodicals and newspapers are acquired by the library to replace a deteriorating copy to save the user the pain of handling a bulky, dirty, crumbling volume and to same shelf space. Working copies of fragile books are acquired both to prolong the life of the original work as long as possible, and as a safeguard against of its final crumbling. In India, Nehru Memorial Library, New Delhi and National Library, Calcutta which are engaged in production of microforms of newspaper and rare documents.

PRESERVATION OF DOCUMENTS

CAUSES OF DETERIORATION AND PREVENTIVE MEASURES OF MICROFORM

There are three components of a photograph. The final image material, the binder, and the support. Every photograph possesses is an image which absorbs or scatters light, and which is comprised of one or more substances. The final image materials of black and white photographs is metallic silver, while in colour photographs, it is three synthetic organic dyes — Cyan, magenta, and yellow, Chemical reactions which affect the ability of the final image material to absorb or scatter light are the immediate cause of image fading, such reactions may be initiated or influenced by pollutants, and will be specified to the type of final image material which is present.

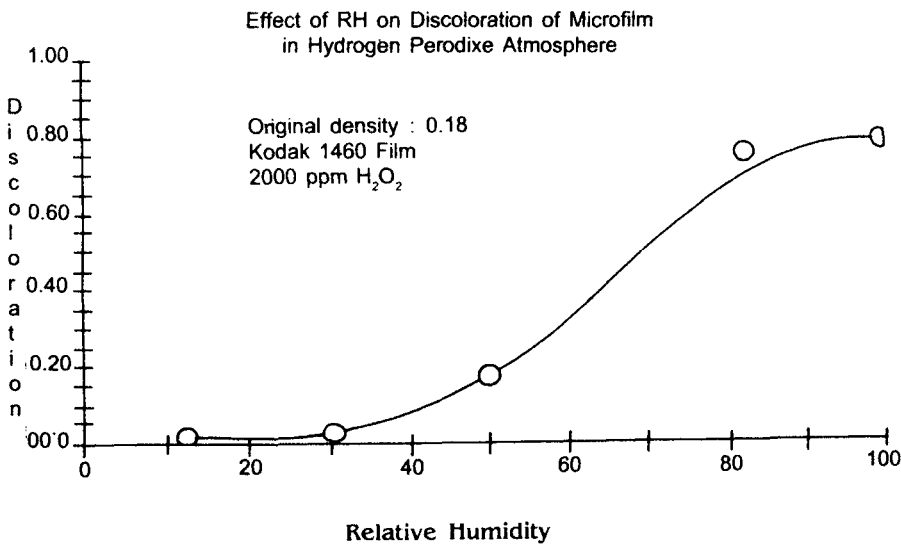
It is to necessity to provide every photograph in a collection with protection against dust. Gaseous pollutants affect not only the image, but also the binder (the transparent layer made of gelatin, albumen, or collodion, in which the final image material for 20th century photographs; it has considerable ability to act as a protective barrier to shield the image substances from atmospheric contaminants. Gelatin is a stable and robust polymer which can sustain attack by acidic gases because of its amphoteric nature, and its structure is such that oxidizing gases cannot easily undermine its physical properties.

The barrier properties of gelatin is very greatly with RH. This is a key fact to consider in all discussion of air pollutant effects on photographs. The strong influence of RH on attack by the oxidant like hydrogen peroxide on silver microfilm can be seen which is observed by James M. Reilly. Discolouration of the film (as measured by transmission blue density increase) is plotted in relation to the RH of the

PRESERVATION OF DOCUMENTS

incubation environment. The peroxide concentration was 2000 RPM in all cases. Attack is virtually prevented below 35% RH. About 60% RH the physical properties of gelatin are radically altered, diffusion can readily occur, and attack on the film is severe. Thus RH control is a very pragmatic way to use the barrier properties of gelatin to minimize image deterioration due to airborne contaminations.

Figure 1



ROLE OF ACIDIC POLLUTANTS IN SUPPORT DETERIORATION

The generic component of photographs upon which the binder is coated referred to as the support of metal, glass and plastic have all been used, and each will have a characteristic response to pollutants of an acidic, oxidizing or sulfiding

PRESERVATION OF DOCUMENTS

nature. Paper and cellulosic plastic supports such as cellulose nitrate and cellulose acetate will have a high sensitivity to acidic gases. Absorption of acids by paper can lead to chain scission of the cellulose by acid-catalyzed hydrolysis. In the case of cellulosic plastic film supports, absorption of acids can initiate hydrolysis of acetyl or nitro side groups; liberation of acetic acid or Nitric acid can then become auto-catalytic, leading to massive shrinkage of other forms of catastrophic deterioration. RH always plays a vital role in deterioration of paper and film.

DETERIORATION OF IMAGE POLLUTANTS

Though colour photographs have a well deserved reputation for image fading is silver (black and white) photographs which are most sensitive to contaminants from the storage environment. This may be seen over and over in actual photographic collections; faded colour images generally have lost density evenly in all areas of the image, while silver images are typically affected unevenly, specially at the edges. Colour images degrade primarily by thermal or photo oxidative processes, and thus tend to fade evenly overall.

With silver (black and white) images, however, many variations on the theme of "Access" by the atmosphere can be observed, either within a given print or film, or among groups of pictures in an album or book where the atmosphere is allowed easy access, fading, discolouration and the form of deterioration known as "Silver mirroring" will usually be in evidence. The prints are relatively well protected from the atmosphere, then they will normally be in better condition. Common examples of this phenomenon include worse fading in the first and last few pages in an album, and the beneficial effects observed when two prints on opposite pages of an album touch each other often the outline of the print on the

PRESERVATION OF DOCUMENTS

facing page is visible because there is less fading where it has been pressed face to face with its neighbour. Close observation of naturally deteriorated silver prints and films shows that the actual course of degradation depends on both the atmosphere and on contaminants which may be introduced by storage enclosures such as mounts, envelopes and boxes.

MECHANISMS OF SILVER IMAGE DEGRADATION

Silver image deterioration is caused by two general mechanisms the best known to photographers and the most widely known as improper original processing, in which thiosulfates or silver thiosulfates are left behind to later react with the image, causing stains or fading. The most important mechanism is a process of Silver Oxidation / Migration / Reduction. In Black and white silver gelatin materials, (films, plates and papers) the image exists as isolated clumps of silver filaments. Any alteration to this efficient physical form of the silver will result in decreased capability to absorb light-in other words, if the original silver morphology is changed, then fading and discolouration of the image will result.

SILVER IMAGE OXIDATION / MIGRATION / REDUCTION

In the presence of moisture and atmosphere oxygen, the metallic silver image will oxidise to some extent. An equilibrium condition is quickly established where some silver become ionized, and simultaneously some silver ions are reduced back into metallic form on the surface of the image filaments. As long as the amount of silver in ionic form remains small, and so long as this equilibrium is undisturbed, little fading will occur. Some silver ions will diffuse through the gelatin away from the filament clump in all directions, but in the absence of species or forces to interact with them and

PRESERVATION OF DOCUMENTS

disrupt the equilibrium, changes in the appearance of the image will be minimal.

Typical symptoms of image deterioration include overall loss of density (fading), discolouration of the image from black to yellow, and formation of a bluish metallic in dark areas of the picture. All of these phenomena result from some combination of oxidation/migration/reduction of silver ions. Atmosphere contaminants can play a destructive role by influencing any of these steps of the deterioration process. One obvious type of undesirable pollutant is a strong oxidant, which drives forward the production of silver ions (oxidation step), withering away the metallic silver image particles. Ionic silver is colourless and does not absorb light, so the more silver in ionic form, the more faded the picture becomes. Common atmospheric oxidants such as ozone and nitrogen oxides are dangerous to photographs.

The oxidation and migration steps of silver image deterioration are strongly influenced by the P^H of the ambient environment. Association of silver ions with water molecules stabilizes them and facilitates diffusion through the gelatin layer. Some atmospheric contaminants can have both an oxidizing and a reducing influence, depending on P^H and other circumstances. Hydrogen peroxide is a good example of this, mechanistically, the catalytic decomposition of peroxide at the silver surface is a multistep process which includes both oxidation and reduction of silver ions. For this reason, attack by peroxide at the silver surface is a multistep process which includes both oxidation and reduction of silver ions. For this reason, attack by peroxide usually produced on orange-red discolouration along with image fading, because considerable amounts of silver ion are reduced, resulting in the growth of new spherical particles of silver metal in the empty gelatin surrounding the original filament clumps. These new particles absorb mainly

PRESERVATION OF DOCUMENTS

blue light, yielding a reddish appearance. Such reddish discolourations are not experienced when oxidants such as nitrogen oxide are immediate cause of image fading.

ROLE OF REDUCING GASES IN IMAGE DETERIORATION

Airborne contaminant of a reducing nature, especially atmospheric sulfides such as H_2S , also a profound influence on silver image deteriorations. As silver ions diffuse throughout the gelatin layer, reducing agents can cause nucleation and growth of new silver particles anywhere in the gelatin or in the paper support, if one is present.

Once a particle of silver or silver sulfide exists, there is a much greater tendency for continuous reduction of silver ions into it rather than to nucleate and form a wholly new particle. Thus the role of absorbed sulfides in nucleating silver sulfide particles at the top of moist surface is an important one because nowhere else in the gelatin emulsion conditions are so favourable for reduction. Gradually, the overall transfer of silver becomes one in which silver metal is drained away from the original image, and either remains in ionic form or becomes part of this new line of particles at the air/gelatin interface. The result is the formation of a "Silver mirror".

The great majority of black and white photographs over the age of 50 years shows evidence of the phenomenon of silver mirroring, a bluish or silvery sheet in the dark areas of the image. The physical cause is the thin layer of very small particles of reduced silver sulfide at the very top surface of the gelatin emulsion layer. These particles which may actually touch each other are at least in "optical contact" in the sense that light rays striking particles below a critical angle are reflected as these would be by a mirror.

PRESERVATION OF DOCUMENTS

The above mentioned factors in combination bring about gradual deterioration of microfilm. The preservation & storage of microfilm & microfiche is essential. For microfilm, these conditions are laid down in Indian Standard I.S. : 3130-1985 : Code of practice for handling and storage of micro transparencies (Microfilm and Microfiche) (Silver Halide).

The following specifications are laid down for microform to be adhered for library preservation and storage.

1. **Library/Archival Quality Film**

Good quality microfilm stored in Libraries are meant to last long. The Library quality micro transparencies should be according to B S I Standard. The Kodak, Agfa, Fuzi brand all are standard microforms available in India. In case of silver film acetate and polyester basis are considered to be of Library/Archival standard. Image of silver film is of pure black metallic silver imbedded in gelatin, which protects it from many harmful effects. In order to test for Library standard of silver film, it should be ensured that residual thiasulphate content of the microfilms after complete processing shall not exceed 7 mg of anhydrous sodiumthiosulphate per square meter is tested in accordance with BSI Standard IS : 6212-1971.

2. **Temperature and Humidity**

Low relative humidity and temperature have little effect on microfilm degradation. Rate of chemical reaction depends on rise of temperature which takes place on the microfilm as per 3rd law of thermodynamics. Heat and humidity can act on the film independently or in combination and render them brittle and weak. Low temperatures and humidity accelerate the growth of micro-organisms and

PRESERVATION OF DOCUMENTS

insects. The best way to maintain ideal temperature and humidity is a condition of the area where the film is stored and handled. In the air condition system air filter, for dust smoke and injurious gases free should be provided. A window air-condition, if installed, can normally control the temperature, but is not capable of maintaining humidity at the desired level. Air conditioning of the storage area should be maintained round the clock to achieve ideal condition for preservation of microform. The recommended ideal temperature is 15-20°C, relative humidity $40 \pm 5\%$ for restoration of Library materials.

3. Proper Handling of Film

Scratches, abrasions and tears mark and destroy the image. Microfilm readers, printers, spools, rewinders as well as containers should be smooth, clean, free of dust and abrasive material. The end of the film strips of rolls should be clipped round to avoid sharp free ends. Films should be handled in a dust-free atmosphere. Exposure of film to sudden or wide variation in temperature and humidity should be avoided. Films transferred in sealed containers from one environmental condition to another should be allowed sufficient time (3 to 4 hours) to attain equilibrium before they are used or stored. Films should be handled only by the edges with clean and dry hands. Use of lintless cotton hand gloves is advisable. Adhesive tapes or rubber bands, likely to stain the film or impair the image on it should not be allowed to come or remain in contact with the film.

4. Housing of Microfilms

Microfilms should be stored in closed housing, such as steel cabinets, drawers or shelves and racks enclosed

PRESERVATION OF DOCUMENTS

by doors. The storage housing material should be non-combustible and non-corrosive, such as anodized aluminium, stainless steel or steel with back or non-plastic synthetic resin lacquer. The storage cabinets should be such as to allow free circulation of air in drawers and compartments.

5. **Packing and Storage of Microfilm Roll**

Microfilm more than 5m length should be stored found on spools or bobbins. The winding should be neither too light nor too loose. The film roll should have a leader and a trailer of at least 0.5m each. The outer most coil of the film, when wound on spools, should be well within the flange. The diameter of the innermost coil of the film should not less than 2.5 cm. The spools or bobbins and cans for storage should be made of stable, non-acidic and non-corrosive material, such as suitable plastics or non-ferrous material plastics and lacquers which might give off reactive fumes, peroxides or oxidation during storage should not be used. The core and the flanges of the spool should be smooth so as not to scratch or damage the film during winding or rewinding. The microfilm spools should be round closed can to protect against dirt and physical damage. Inter filling of vesicular and silver film for archival storage is not recommended. Interfilling of used copies is acceptable.

INSPECTION

Durability of photographic records depends upon temperatures, humidity, cleanliness, handling and process of film. It should definitely be kept under the recommended storage condition where humidity is not controlled closely, the film should be inspected more frequently than at two-year intervals. It is not

PRESERVATION OF DOCUMENTS

always possible to open every film can or to rewind every roll at the recommended frequency. Though inspection is laborious job, in order to avoid it, a few rolls should be selected at random sampling from the film whole collection each month for examination. If it indicates the film records are not kept properly, storage conditions should be improved and other protective treatments given to the film.

Indian Standard IS : 3130-1985 suggests the following inspection procedure

- i) Inspection of microfilms stored as well as their containers should be done at six-month intervals according to a pre-determined sampling plan established in advance.
- ii) Different lots should be inspected each time.
- iii) Inspection of the film should be carried out for physical damages in the film, such as carl, distortion, brittleness, adhesive failure, degradation of base or emulsion layer and for VISUAL damages, life spots, stains, fading, blemshes etc.
- iv) Films showing damages or deterioration should be duplicated.
- v) Causes of deterioration noticed should be analysed and corrective action taken.
- vi) Cans and envelopes containing microfilche which show signs of corrosion and fungoid growth should be replaced.

STORAGE EQUIPMENT AND MATERIAL

Follow up appropriated filling methods and proper handling of microforms are important in the restoration of records. The Librarian should set up arrangements to safeguard against loss

PRESERVATION OF DOCUMENTS

or misplacement of valuable records in the Library, 35mm x 33.3 mt microfilms positive or Negative (Kodak) should be on metal (aluminium) or plastic spools and kept in individual metal or plastic cans. It is filed in steel cabinets which have adjustable drawers, one drawer is divided in four with partitions. Restoration of microfilm cartridges and cassettes do not need further incasing. It is generally filed in open plastic or steel racks. Microfiches are generally kept in individual paper envelopes and filed in plastic boxes which may be filed in a steel cabinet.

The enclosure materials like paper, plastics used in the manufacture of microfilm cans, spools, envelopes and wrapround straps, etc. release harmful gases which over a period of time have a deleterious effect on the microfilm. All packaging materials should be free from acidic, oxidising and reducing agents, polyesters or polypropylene has been considered suitable for use in packaging of microfilm which are not acidic in nature, polyvinyl chloride should not be used.

Tin can corrodes at high humidity and temperature, where air conditioning is not available in the storage area. When it corrodes, it becomes difficult at times to open those without damaging the films. It is, therefore, advisable to use nylon, polyester, plastic cans and spools of good quality. For the conservation of microfilm steel cabinets should not be used immediately after painting for storing microfilms. Thinner generally used in painting which is normally an organic solvent. The vapour of organic solvent severely damages the microforms emulsion and the base material.

Fire resistant steel cabinets should be used for ensuring safety against fire. Aging test of film at 105°C temperature for 72 hours have been made without significant loss in readability or printability. At 300°F (149°C), and 75% R.H. takes place

PRESERVATION OF DOCUMENTS

severe deterioration in a few hours.

Microforms positive copy can be shelved in a variety of ways. The most satisfactory way is to use specially constructed slide drawer metal cabinets. These cabinets are designed specifically to accommodate reels of microfilm or sheets of microfiche and protect these from dust and dirt, in addition these enable efficient utilization of floor space. The cabinets have about 4" height as office file cabinets, but some are so constructed that these can be double stacked where ceiling height permits. Multiple stacking reduces the floor space requirement, this practice makes access to the higher drawers inconvenient and is not recommended for active microform files.

A method for conserving microfilm reels in Libraries is to place those in their labelled container boxes open-stack permits the use of readily available space, but space utilization is not efficient, dust protection is not possible, and losses occur when boxes set pushed out of sight to the rare the shelf.

Where in-house production facilities exist, low cost shallow depth shelves have been fabricated of sheet metal for restoration of reel microfilms at the rare book division of National Library. Some Libraries have such shelves installed on the walls of book stack areas. Standard stack shelves should be used in order to save space and reduce incidence of loss.

Shri A. K. Avasthi, Nehru Memorial Museum Library, New Delhi, cited a recent development in microfilm storage is the cartridge carousel filling system for both roll and sheet microforms. Single tiered, desk-top units, moveable at finger touch, to seven tiered, motor driven units up to 8 feet in diameter, are available. A single tiered, disk-top unit is said to

PRESERVATION OF DOCUMENTS

house 5,000 microfiches in special cartridges, while a tier of a larger diameter carouse is said to house more than 1,25,000 microfiches. Such equipment is expensive, but the loss can be justified on the ground of compact storage of high use material requiring rapid access. These storage equipments are not available in India at present.

Microfilms should be stored in metal cabinet which have adjustable shelves. In the National Library, air conditioning is set up for preservation of Library records.

Microforms have a tremendous role to play in the preservation of the textual content of a great proportion of library materials, current and retrospective, and with the linkage of microforms to the computer, it is possible to give easy, quick and wide access to library materials. Microforms represent the key to fulfilling today and in the future, the need for storage and retrieval of vast amount of information. The increasing popularity of publishing on microfilm which we see today is certain to accelerate the replacement of conventional media with the microfilm.

TEST FOR RESIDUAL HYPO CONTENT IN PROCESSED FILMS

Preparation of standard sample

A strip of film of the same type as under test and exposed and developed for the same period, fixed twice in two fresh fixing baths consisting of 250 gms of hypo in one litre of water shall form the standard sample. The standard sample after fixing shall be washed in running water for one hour and shall be airdried.

Test method

A test strip of 625 mm. is kept in 10cc of a solution containing 25 gms. of mercuric chloride and 25 gms. of

PRESERVATION OF DOCUMENTS

potassium bromide in one litre of distilled water. If the solution shows no turbidity after 15 minutes, the hypo elimination is considered as satisfactory. The transparency of the solution containing the test strip shall be comparable to the standard sample kept in a similar manner.

A more accurate estimation may be made by a test based on Crautria and Rose method. In this method the turbidity of the solution containing test strip is compared with three similar vials of mercuric chloride, potassium bromide solution (Each 10cc of solution containing 25 gms. of mercuric chloride and 25 mgs. of potassium bromide in one litre of distilled water) one containing no hypo, the other with 0.005 mg. of hypo and the third sixth 0.010 mg. of hypo. The turbidity of the solution containing test strip should not exceed that of the solution containing 0.005 mg. of hypo.

Spot test for Residual hypo in processed films

A spot test is carried out by putting a drop of 1% solution of silver nitrate on the clear margin of a film, it will produce a colouration in excess of pale cream when the hypo content of the film exceeds a safe level.

Test for residual silver compounds in processed films

A drop of 0.2 percent sodium sulphide solution is put on the clear margin of the film after washing and drying. After two or three minutes the spot should be carefully blotted. Any colouration produced by the formation of silver sulphide in excess of a just visible cream tint indicates the presence of silver compounds in the film. For more accurate results, a standard sample may be prepared as described earlier by processing an unexposed strip of film through two fresh fixing baths and making a spot test. The colouration or tint produced in the test strip should not be deeper than that developed in the standard sample.

PRESERVATION OF DOCUMENTS

Appendix — I

TESTS OF STABLE PAPERS

The paper has made place for itself as record material and its lasting qualities are of prime concern as the same papers having poor aging qualities. But it is not necessary to discard all papers of today as unstable. A well organized Laboratory can test the quality of subjecting to artificial aging. The accelerated aging test has made it possible to predict the future life of paper, its durability and permanency.

Laboratory testing requires expensive equipment, a great deal of time as well as experienced and trained personnel in the line is needed. Often the users of paper require to recognize, examine the qualities of papers for the purpose of stabilization and restoration and also to avoid using unsuitable papers where permanency is required. Speedy spot tests have been developed by William J. Barrow's Laboratory to assist the testing for approximate assessment of the quality of a paper. These tests are visual and can be done even by lay persons having little scientific background.

Permanency and suitability of paper for archival and library use depend on four undermentioned factors :

- a) Free from ground wood
- b) P^H of 6.5 and above
- c) Free from alum
- d) Free from alum rosin sizing

Collective results of these tests, distinguish stable and unstable book and record papers. The results will give only qualitative character. For example acidity test will indicate the presence of acidity but not the exact amount of acid.

PRESERVATION OF DOCUMENTS

Test for ground wood : Paper containing ground wood are weak and unstable because of the impurities like lignin. If ground wood content is high as in news print paper, the life expectancy of this paper is only 10 to 20 years and a bit high if an alkaline fill is given. If ground wood is found to be present the paper may be classified as unstable without going for other tests.

The test reagent consists of one gram phloroglucinol in 50 ml of methyl alcohol and 50ml of hydrochloric acid. A thin line of the solution is applied on the paper under testing with a glass rod or medicine dropper. If colour of the line remains unchanged, ground wood is absent and if it changes to purpled, the ground wood is present. Care should be taken not to run any other spot within one inch. For good results push reagent is available. The prepared reagent may be stored in cool and dark place.

Test for acidity : Papers with high acidity have poor aging qualities. The testing solution for the purpose consists of 420 gms of chlorophenol Red in 1000 ml of distilled water. It is applied with medicine dropper or glass rod on paper about one inch in length. If the colour changes to yellow the paper is strongly acidic (p^H below 6.0). If the spot turns definite purple the paper is neutral or alkaline. There may be different shades of colour like green, gray, greygreen or yellowgreen (pH 6 to p^H 6.7). The reagent should be allowed to dry before results are determined. Most of the present day papers have their p^H less than 6.0.

Test for Alum : The testing solution consists of one gram of aluminon in one litre of distilled water. A thin solution of the reagent is run on paper with glass rod or dropper. The paper will remain faint pink or will become colourless if no alum is present, it will turn bright or deep pink if alum is present.

Loading and sizing Test in Paper

Loading is one of the constituent of the writing paper which is required to ignite in order to destroy the organic constituents, and it is important to note at this stage whether the ash is coloured or not a black colour if carbon is due to insufficient ignition. This operation may be carried out in a platinum dish, or if this is not available, the paper may be rolled up and held in the flame by means of a piece of stiff twisted iron wire.

If 1 gm. of paper is weighed out originally, then the final weight of the ash multiplied by 100 gives the ash percentage. This weight includes the mineral matter natural to the fibre and contained in the sizing etc. and it is, therefore, a measure of "Loading present" rather than of added loading. The ash then examined as follows.

China clay is insoluble in water or in cold acid or a alkali. The ash is boiled with dilute hydrochloric acid and the residue is removed by filtration, dried and fused in a platinum crucible with excess of a mixture of equal portions of solid sodium and potassium carbonate. The resulting mass is boiled with water and filtered. The new residue is treated with hydrochloric acid. If it dissolves China Clay is absent and barium sulphate has been used.

Calcium sulphate (gypsum, pead hardening) is slightly soluble in water and soluble in warm dilute hydrochloric acid. In the ash, the mixture may be filtered, and the resulting liquid is cooled and divided in two portions which are tested as follows.

A 10 percent solution of barium chloride is added, when a heavy white precipitate of barium sulphate results. The reaction may also be given to a slight extent by aluminium sulphate from the sizing, and in cases of doubt, this should be

PRESERVATION OF DOCUMENTS

removed as described above.

The presence of calcium in traces only is probably due to the hard water and not to the presence of added loading calcium carbonate dissolved in acids with effervescence and the filtered solution then gives the reactions of calcium.

Titanium loading

The ash is boiled continuously with concentrated sulphuric acid, to which a little solid potassium bisulphate is added. After about five minutes the liquid is carefully cooled and diluted, and hydrogen peroxide is added. Titanium produces with golden colour or Orange Colour.

Zinc loading (Zinc oxide, Zinc sulphide, Lithophone)

The ash is warmed with dilute hydrochloric acid which liberates hydrogen sulphide gas from zinc-sulphide. This gas is recognised by the odour and the production of a black or dark brown colour on a piece of filter paper when soaked in lead acetate solution when this is held over the mouth of the test-tube.

Zinc loading has a characteristic fluorescence and usually associated with Titanium or barium sulphate.

Starch Sizing

The paper is smeared with a solution containing 1 percent of iodine dissolved in a 5 percent solution of potassium iodide. A deep blue stain indicates ordinary starch, and if on examination under a lens it is shown to consist of tiny granular specks, the inference is that the starch was added dry to the beater. A reddish-blue stain, however, indicates a modified starch which might have been added either in solution to starch or in solution to the beater, or else used

PRESERVATION OF DOCUMENTS

along with gelatine to subsize the paper.

Wax sizing

The paper is torn up and shaken with warm ether in a flat bottom flask on the water bath, the solvent being then evaporated. About 5ml. of a solution of potassium hydroxide in alcohol is then added to the residue, and the mixture is evaporated on the water-bath in a glass dish. This saponifies any rosin (from the sizing), and the dry residue may then be extracted again with ether. This removes the wax, which is left in a fairly pure state after evaporation; it may be purified further by dissolving the extract in hot acetic anhydride, from which the separates on cooling.

Casein Sizing : If the milled edge of a silver coin is drawn across the sheet, a black line remains. This test is reliable only as a positive indication, although no uncoated papers give it, yet a few types of coated papers do not.

SPOT INK TEST

1. Put a drop of 5% acetic acid on a tail of a written letter. After a few moments pick it up with a white blotter.
2. Put a drop of potassium ferrocyanide (1% solution) on the wet of the blotter.
3. If iron is present, a blue colour will appear on the blotter.

OR

- i) Put a drop of 4% sodium hydroxide solution on the writing and pick it up with blotter.
- ii) If iron is present a dark red brown colour will appear on the blotter. If the ink is logwood the colour will be brown.

Appendix — II

FIBRE QUALITY TEST

α, β AND γ CELLULOSE

Fibre quality tests are applied to pulps for delating deterioration of the cellulose through oxidation or hydrolysis. These are applicable to paper which consists chiefly or wholly of rag or bleached wood pulp fiber and serve to indicate the quality of the fiber furnish.

The following procedure is essentially that of TAPPI T 429 and ASTM D588. α and β plus γ cellulose are determined by an oxidation procedure. The α cellulose can also be determined gravimetrically.

Appratus :

1. A water bath maintained at $20 \pm 0.1^{\circ}\text{C}$.
2. Electrometric titration appratus (if a redox indicator is not used). A simple apparatus is described in the TAPPI and ASTM standards. A pⁿ meter or other potentiometer with platiums and calomel electrodes can also be used.

Reagents

1. Sodium hydroxide solution, 17.5%, 5.24M : A strong solution is prepared by dissolving sodium hydroxide pellets in an equal weight of water. The solution is allowed to stand for about 1 week to permit settling of the insoluble sodium carbonate. A portion of the clear solution (2.00ml) is removed with a pipet and transferred to a flask. Distilled water (50ml) and 1.5 M Barium

PRESERVATION OF DOCUMENTS

chloride solution (1M) are added and the solution is titrated with 1 M Hydrochloric acid (Phenolphthalein indicator). From the concentration found, the strong solution is diluted with distilled water to 5.24 ± 0.05 N ($17.5 \pm 0.2\%$). The concentration of the diluted solution is checked by titration of a 10ml portion and further adjustment is made if necessary.

2. Potassium dichromate solution : Reagent grade $K_2Cr_2O_7$ (90.0g), dried at 100 to 105°C, is dissolved in hot water (70-90°C). The solution is cooled and diluted to 1 liter.
3. Ferrous ammonium sulfate solution : The reagent-grade salt (195g) is dissolved in water (about 500ml) containing sulfuric acid (10ml. 1.84 specific gravity) and the solution is diluted to 1 liter).
4. Phenanthroline (Ferroin) is an indicator.
5. Sulfuric acid, 24N : Concentrated sulfuric acid (300ml), 1.84 specific gravity is added slowly with constant stirring to water (200ml) in a flask cooled with tap water.

PROCEDURE

The paper is defibrated in a disintegrator. If the paper is coated, the coating is removed before disintegration. the solution required are adjusted to $20 \pm 0.1^\circ\text{C}$.

2 - Cellulose : The sample (0.3 ± 0.01 g) is weighed and placed in a 100ml beaker. Sodium hydroxide solution (17.5%, 20.0ml) is added and the fibers are macerated until they are uniformly wet and dispersed. After 10 min, water (33ml) is added and the mixture is stirred thoroughly and allowed to stand for 1 hr with occasional stirring. (The total time from first addition of NaOH is 70 min.) The mixture is stirred again and filtered on a coarse-porosity fritted glass crucible on a

PRESERVATION OF DOCUMENTS

filter flask, but with out application of suction, until a fiber mat has been formed on the bottom of the crucible. The filtrate is transferred to a 100ml volumetric flask, the fibers are washed on the crucibel with water (35ml), and the wash water is transferred to the volumetric flask. The suction flask is rinsed with water which is added to the volumetric flask until the volume is 100ml.

The α -cellulose in the crucible is transferred to a 400ml beaker, the crucible is supported over the beaker, and 24N sulfuric acid (25ml) is added and allowed to drain through. After a few minutes an additional 50ml of the acid is added as a rinse. The α -cellulose is disintegrated in the acid with a stirring rod, and potassium dichromate solution (25.0ml) is added from a pipet. The beaker is covered with a watch glass and the solution is heated at 140 to 150°C for 10 min. with a fine steam of air bubbles passing into the solution through a bubbling tube to prevent bumping. The solution is cooled to about 130°C and, after addition of water (50ml), to 60 or lower. The excess dichromate is titrated with ferrous ammonium sulfate (Ferroin indicator).

β and γ Cellulose : Exactly one-half the filtrate (50.0ml) is removed from the volumetric flask with a pipet and transferred to a 400-ml beaker containing 5.00 ml of the dichromate solution. Concentrated sulfuric acid (50ml) is added slowly and with constant stirring down the side of the beaker. The solution is heated and titrated as described above.

Calculation

$$A = 25 - (V_1 r)$$

$$B = 2 (5 - v_2 r)$$

PRESERVATION OF DOCUMENTS

where

A and B are milliliters of dichromate solution required for the oxidation of the α cellulose and filtrate, respectively, v_1 and v_2 are milliliters of ferrous ammonium sulfate solution for titration of the excess dichromate

r = milliliters of dichromate equivalent to 1 ml of ferrous ammonium sulfate solution. This volume is determined by titrating the dichromate (5.00 ml) in dilute sulfuric acid (1:1, 100 ml)

If the paper contains rosin starch, or glue sizing, the volumes of dichromate solution are corrected before calculating the percentage of α cellulose. The amounts of sizing materials remaining with the α cellulose are assumed to be 0.2% rosin, 0.2% starch, and 0.25% glue. These values are converted into weights and then into milliliters of the dichromate solution by dividing each weight by the following factors: rosin, 0.005; starch, 0.0129; and glue, 0.0154 g/ml. The sum of the three volumes (in milliliters) are subtracted from v_1 . The total content of rosin, starch, and glue in the paper must be determined by separate analysis of the paper. The percentage of each sizing material which appears in the β plus γ cellulose fraction is found by subtracting from the original percentages remaining in the α -cellulose. These values are converted into weights and then into milliliters of dichromate as described above, and the sum of the three volumes (in milliliters) are subtracted from v_2 . The percentage of α -cellulose is then calculated from the corrected volumes of A and B.

$$\alpha - \text{Cellulose (\%)} = \frac{A \times 100}{A + B}$$

PRESERVATION OF DOCUMENTS

Test of paper fiber

Fibers	Iodine	Zinc chloriodine solution	phloroglucinol solution	Herzberg's Stain
Cotton and linen	light to dark brown	Strong wine	—	Red
Chemical wood	colour less to brown	Blue	—	Blue
Mechanical wood	Yellow to Brown	Yellow	Dark	Yellow
Straw	colourless to light brown	Blue	—	—

Appendix — III

MICROSCOPIC ANALYSIS OF FIBRES

Before chemical treatment of document for conservation, the composition and fibres and dating of the same should be ascertained. Steriozoom of Microscope with microphotographic attachment and very high magnification enables to detect the fibre content which could be estimated very easily and quickly in most cases, the procedure being simple to disintegrate the fibres and spread them on a glass slide. These may be dried and stained and the various types of colours with the different fibres. But in the few cases where these are not dried, one has to rely on differences in step and general structural characteristics. It is suggested to keep standard mixture of fibres in various known proportions for reference from paper-makers.

Preparation of Specimen

- i) If the paper is available in unlimited quantities, a square of about half an inch inside is torn up and just covered in a small glass beaker with a 0.5% solution of Sodium hydroxide, which is then gently boiled.
- ii) The paper is thus beaten up into fibres, which may be separated on a small metal sieve (200 mesh) and washed well with water.
- iii) The moist pieces are then rolled into a ball and are worked with the fingers so as to loosen the fibres. The fibres in a portion of the ball are then separated by shaking well in a test tube containing water.

PRESERVATION OF DOCUMENTS

- iv) In order to get a concentration of 1 Percent sufficient quantity of the mixture is then transferred to another test tube containing water, and continue shaking operation continuously.
- v) By means of a glass fountainpen filter a sufficient number of drops (usually four) of the fibre suspension are transferred to a clean slide so as to cover it uniformly without any overflowing at the edges. This should be done before the fibres settled.
- vi) The slide is placed on a flat warm surface (warm hot plate) until it is just dry. The fibres will then form a thin hard surface layer which cannot easily be removed without willing.
- vii) One drop of the appropriate stain is placed on a glass coverslip about $\frac{3}{4}$ " in diameter which is thin quickly inverted and placed centrally on the side in such a way that no portion of the property is lost and a few air bubbles as far as possible are included. This operation is assisted by subsequently gently pressing the cover-slip into contact with the slide so that air bubbles and any excess of stain are expelled from the edges of the slip. The latter may then be removed carefully by means of blotting paper. A staining period of about thirty seconds is needed before the slide is ready for examination.

Preparation for examinations. The slide is examined on the Zoom microscopie stage, with the best degree of illumination which is obtained by adjusting the mirror.

Stains : Although a large number of different stains exist for various fibres, it is realised that for the present purpose there is no object in duplicating the methods as this may be the

PRESERVATION OF DOCUMENTS

simplest and most effective one. Stains only will therefore be described.

The Herzberg Stain : This is the stain most frequently used for paper fibres, for not only it has a greater degree of colour selectively than any other stain, but it also brings out the details of the structure very effectively in the case of those fibres which are not stained, with a selective colour. It is prepared from solutions as follows :

- 1) A saturated solution of pure zinc chloride in distilled water prepared at 70°F.
- 2) A solution containing 0.25 grams of iodine and 5.25 grams of potassium iodide dissolved in 12.5 ml. of distilled water.
- 3) The whole of the Solution (2) is then added to 25ml of Solution (1) and the mixture is allowed to stand in a cylinder until it becomes clear. A central rod is fixed into the groundglass stopper and this enables a drop to be removed at a time. It should first be tested out against known fibers, because it may occasionally fail to distinguish clearly between rag and wood in the way described below. If the stain gives a blue colour in both cases some more zinc chloride must be added, if the colour is red, in both cases, more iodine is required.

The correct colours are as follows :

Red : Linen, Cotton and bleached manilla hemp

Blue : Sulphite or Sulphate chemical wood, Esparto

Straw, Bamboo and most other chemically treated fibres or fibres free from lignocelluloses.

PRESERVATION OF DOCUMENTS

Yellow — brown — Chemical wood in which the cooking has been incomplete, with the result that some lignins are still present. Certain sulphate and craft pulps are examples.

Bright yellow : Materials containing lignin, e.g. groundwood, Jute and unbleached manilla hemp.

Phloroglucinol Stain : The stain is prepared by dissolving 4 grams of pure phloroglucinol in a mixture of 100ml. of alcohol and 50ml conc. hydrochloric acid. It can be applied directly to the surface of the paper without using of slide. A drop is smacked on the paper, and after about one minute this is examined under lens. If groundwood or lignified fibres are present, these can be seen as long thin deep red marking.

Structural Characteristics

The stains described above enable differentiation to be made between most of the fibres in terms of the colours produced. It will be realised, however, that these colour reactions really only divide the fibres into groups without distinguishing between the individual members of each group. Thus for example, a blue colour with the Herzberg stain is produced by chemical wood, esparto and straw alike, and all "rags" give a red colour.

As a further aid it may be mentioned that the Herzberg stain is preferable to the others as a means of bringing out these details of structure, and that is an advantage where possible to divide the process of examination into two parts. viz.

- a) The fibres themselves
- b) Associated structures

Different Categories of paper pulp structure are given below for microscopic identification of fibre.

PRESERVATION OF DOCUMENTS



PRESERVATION OF DOCUMENTS



PRESERVATION OF DOCUMENTS

Appendix — IV

SPECIFICATION OF REPAIRING MATERIALS

HAND MADE PAPER

Hand-made paper for repair and rehabilitation of documents should be permanent paper such as all rag, cotton, which are white.

Folding endurance at least 1000 folds at 1 kg tension under I.S.I. test condition (Method of sampling and test for paper and Allied product part I, IS : 1060-1956, IS : 1060 (part III)-1969.

TISSUE PAPER

Tissue paper for repair of documents should conform to the following requirements :

Thickness

Alpha cellulose content not less than 88%

Weight 9 to 10 gms/square meter

Size 52 x 75 cm., 500 sheets

Ash content not more than 0.5%

p^H not less than 6

Free from oily and waxy constituents

Long cloth/Ardi Cloth

Long cloth or ardi cloth use for mounting maps and charts of heavy weight shall be of fine bleached quality having average thickness of 0.08mm. and mesh count 35 x 28 approx per sq. cm. It shall be of even weave, free from knots etc. threads and shall not contain sizing materials.

Cellulose acetate foil

Cellulose acetate foil for lamination of documents is normally

PRESERVATION OF DOCUMENTS

available in 107 cm. (42 inches) width roll but may also be supplied in sheets cut to desired size.

The formula of the cellulose acetate foil recommended for use in lamination of documents by the National Bureau of Standard, Washington manufactured by M/s. Celaness corp. of America.

The cellulose acetate foil recommended for lamination should have a thickness of .0223 mm. and should be flexible, semi moisture, proof and should not change in colour and flexibility when subjected to accelerated ageing at $103^{\circ} \pm 2^{\circ}\text{C}$ for 72 hours. It should be free from nitrate, and should have a stable plasticizer.

Chemical and Physical Parameters of Book Binding Leather
(ISI 2960-1964 Specifications)

Sl. No.	Characteristics	Requirements
i)	Oils and fats by weights	5% to 8%
ii)	Water soluble matter by weight	6%
iii)	Insoluble ash by weight	
	a) Vegetable tannage,	1.0
	b) Full-chrome tannage, or of chrome-vegetable combination tannage	5.0
iv)	pH of water soluble	4.5
v)	Hide substance, by weight	45% to 55%
vi)	Degree of tannage for vegetable tanned leather	50% to 60%
vii)	Thickness mm	
	a) Range	0.7 to 0.9
	b) Tolerance on individual thickness with the range	0.1
viii)	Tearing strength, kg/cm thickness, Min.	8.0

PRESERVATION OF DOCUMENTS

i) **Sewing thread**

The sewing thread shall be unbleached linen or good quality cotton. It shall be unsized and not less than three cords. The thread used for books shall be capable of withstanding a breaking load of 2.5 kg while that for reference volume shall withstand a breaking load of 5.0 kg. The thread shall be soft enough not to injure the paper at turns.

ii) **Tapes and Cords**

Tapes and cords shall be of unbleached cotton and linen. Unsized and free from loose threads and mechanical defects.

iii) **Straw Board**

Both sides of the board shall be clean, free from lose fibres, lumps and mechanical indentations. It should be uniform.

Thickness	Substance	Ash content	pH
More than 2.55 mm	1 ½ bls. GSM		
More than 3.00 mm	2 bls GSM	Not more than 15%	Not less than 6.5
More than 3.45 mm	2 ½ bls. GSM	"	"

PRESERVATION OF DOCUMENTS

iv) **Art Canvas/Calico Binding/Rexin**

The fabric base shall be unsized cotton evenly woven, free from pin holes and other mechanical defects.

The finished cloth shall be soft, pliable and shall not show any sticking when folded upon itself. The cloth is satisfactory finishing and tooling by hand.

Characteristic covering materials

Type of cloth	Weight of the finished fabric gms/sq. meter	Percentage of filling or coating over weight	Thread count average web and filling (2.5 x 2.5cm)	Ash content (percentage of finished cloth)
Art Canvas	Not less than 400 but not more than 600	more than 35	70 double thread	Not more than 5
Calico binding cloth	150 - 250	not more than 70	110	Not more than 15
Rexine	250 - 450	Not more than 80	120	Not more than 15

v) **Adhesives**

- a) Glue shall be hide glue, clean, translucent and amber colour, liquid glue prepared for binding shall

PRESERVATION OF DOCUMENTS

not be treated over 54.5°C (130°F) and shall contain 2.3% glycerine and 1% phenol.

b) Binder’s paste shall be prepared from the maida (Starch) and shall contain 2.3 percent by weight of Barium Carbonate/Copper sulphate and 1.2 percent glycerine.

c) **Paper for guarding**

Hand made paper, good quality paper shall be used. The paper shall have a folding endurance of over 1000 double folds at 0.5 kg tension and, its pH shall not be less than 5.

vi) **Reinforcement fabrics**

The fabrics used for reinforcement at the folds of end paper or spine etc. shall be of unsized cotton free from weaving defects and loose threads.

The fabric shall be soft pliable

Characteristics

Type of cloth	Thread count wrap & filling average (2.5 x 2.5cm)	Thickness average	Weight finished fabric mg/sq. meter
Long cloth	160	0.15 cm	120
Malmal	160	0.10 cm	40
Gauze	40	0.15 mm	25

PRESERVATION OF DOCUMENTS

SPECIFICATIONS OF PAPER AND INK FOR PERMANENT DOCUMENTS

PERMANENT PAPER

The following specifications have been prescribed by the Indian Standards Institution IS : 1774-1961 : Specification for paper for permanent document which is required for preservation.

A. Chemical requirements

1. Rag content (Cotton and lines singly or 100% mixed)
2. Alpha cellulose content 85% Minimum
3. Copper number 2% Maximum
4. Ash content 2% Maximum
5. Rosin content 1.5% Maximum
6. pH 6.0 Minimum

B. Physical parameters

1. Burst factor 25
2. Folding endurance Minimum 250 double fold,
average each direction, at
1 kg. tension under ISI
test conditions
(Method of Sampling and
test for paper and allied
(Products Part. I. IS-1060-1956) ,
3. Stensile strength 5 kg Minimum

C. Aging test (heating for 72 hours at $103^{\circ} \pm 2^{\circ}\text{C}$)

1. Retension of alpha cellulose 98% Minimum
2. Increase in copper number Not more than 0.5
3. Percentage of the un-aged
folding strength retained by
the sample after ageing 50% Minimum

PRESERVATION OF DOCUMENTS

D. General requirement

The paper shall be uniform in formation, thickness and substance, evenly finished, and free from specks, holes or other blemishes. It shall be suitable for ruling and writing with ink, with good erasing quality.

SPECIAL CARE OF LEATHER-BOUND VOLUMES

Good quality vegetable tanned leather is ordinarily a very stable substance, but in adverse circumstances it is liable to be attacked by insects and fungi. It contains waxy and greasy constituents which gradually volatilize in hot climate, and thus leather often loses its flexibility in course of time.

The durability and longevity of leather can be greatly enhanced by the application of leather preservative dressing to leather-bound volumes. Many varieties of leather preservative dressing are available. However, a mixture prepared with the following formula has been found quite satisfactory :

- | | |
|----------------------|--------|
| 1. Lanolin anhydrous | 800 gm |
| 2. Bees-wax | 15 gm |
| 3. Cedar-wood oil | 30 ml |
| 4. Benzene | 350 ml |

Benzene is slightly heated and the wax is dissolved in it. Cedar-wood oil is added next and then lanolin, which should be previously softened by warming. The mixture should be thoroughly shaken before using.

The reasons for combining these ingredients in this leather dressing are as follows : Lanolin is an animal fat which is easily absorbed by leather, and does not become rancid. At ordinary temperature it is in the form of a thick grease and its use will be difficult. Its application is made easy by mixing it with the liquid dressing. The wax will assist in polishing and providing

PRESERVATION OF DOCUMENTS

a thin surface film and will reinforce any powdery or cracked portion of the leather. The cedar-wood oil is a good preservative and is useful in forming a bond of union between the lanolin and wax in the leather. Benzene is chosen as a convenient "thinner" as it readily dissolves bees-wax.

Since acidity in the leather or in the atmosphere is injurious to it, and accelerates its decomposition, treatment of leather with a buffer salt (sodium benzoate) prior to application of preservative dressing is recommended. The process of treatment is as follows :

Superficial dust particles are first cleaned from the leather binding with a clean and soft cotton cloth. A wet swab dipped in 1-2% sodium benzoate solution is applied to it and allowed to dry. After the leather is dry, leather preservative dressing is applied to it with a brush and the volume is again left to dry. The leather dressing is then well rubbed with cotton or cloth pad. Leather is treated, retains its natural shine and flexibility.

The mixture is highly inflammable and should be kept away from fire.

PRESERVATION OF DOCUMENTS

Appendix — V

Examination of paper quality before use as Preservative material

The deterioration of paper is dynamic process which can be retarded highly by using permanent durable paper as preservative material.

The permanency of paper depends upon the following criterians which are furnished below. There are two main criterians, one is physical parameter of paper and another is chemical parameter (Testing procedure is furnished as per IS : 1060 part-I-1956, IS : 1060 part II and part III-1969 IS : 1060)

PHYSICAL PARAMETERS

Tensile Strength and Stretch

This test is performed to determine the resistance to pull of paper, and the percentage elongation the paper undergoes before fracture. The tensile strength is greater in the machine direction than in the cross direction. The elongation is usually less in the machine direction than in the cross direction.

A single lever pendulum dynamometer designed to indicate the tensile strength and elongation simultaneously on two different scales with the help of two different pointers actuated by separate mechanisms with an arrangement to control the rate of loading.

Before starting, (a) see that the machine is level with pointers at ZERO reading (b) align the test piece properly in the plane of jaws, and (c) clamp it free from slackness.

PRESERVATION OF DOCUMENTS

Cut out test pieces of paper, 15mm wide, from both the machine and cross directions of each specimen with a special guelotine in which the position of the cutter blade is adjusted to the required width size of test piece. Clamp one of the pieces in the two jaws initially spaced 180mm apart. Run the motor and control the rate of loading at 225 to 450g (or 0.5 to 1.1lb) per second when the tensile strength falls within the range 0 to 5 kg and at 450 to 675 g (or 1 to 1.5 lb) per second when the tensile strength is above 5 kg, until the breakage of the paper takes place. Take the readings on the load and the elongation scales. Reverse the gear to bring the machine to its starting position, release the pointers of both scales to ZERO position, and repeat the test on a test piece cut in the other direction. Make such determinations for all the pairs of test pieces. Reject readings when the specimen slips in the jaws or is fractured in or at the edge of either jaws. Whenever possible, record each reading to three significant figures.

Size of Test piece

It is not necessary that the test piece of the paper for such tests shall only be 15 mm wide and fixed between jaws 180mm apart. These may be of any convenient size within the following limits, depending on the machine, subject to the condition that the ratio of the distance between jaws to the width of the specimen, shall be not less than 5 to 1, nor more than 15 to 1

Limits	Initial distance between the jaws width of strip	90 to 190 mm 12.5 to 37.5 mm
--------	--	---------------------------------

Report the average, maximum and minimum values of the determination. Express the tensile strength in kilogram per cm width to three significant figures and the stretch in each

PRESERVATION OF DOCUMENTS

direction separately as percentage elongation correct to one place of decimal. The exact width of the test piece and the initial distance between the jaws shall be reported with the results.

Bursting Strength

General : The popularity of bursting strength test depends not only on the case with which the test is made, but also on the combination of strength, 'give' and the touchness which it measures and which serve as a measure of the serviceability of paper in various applications. It has the disadvantage, however, that it depends in a complicated way on the machine direction, tensile strength, stretch and on the size of the burst area. Also it does not give any indication of the cross direction of tensile strength.

Equipment : A tester in which the testing is done by hydraulic pressure which is communicated through the medium of glycerine or by compressed air to a pure gum rubber diaphragm in contact with the paper shall be used. The gauge used shall be so chosen that the individual reading shall not less than 25 percent or more than 75 percent of the total indicated capacity of the gauge.

Procedure : Clamp the test piece firmly over the diaphragm without slippage during the test between two annular plane unpolished (matter) surfaces of 30mm (1.2 in) internal diameter. Run the machine so that the pressure increases at an uniform rate of approximately 0.75 kg/sq cm (10 lb/sq. in) per second until the test piece bursts. Note from the pressure gauge, the pressure in kilograms per square centimetre at which the test piece bursts. Take one reading with the wire side uppermost and one with the top side uppermost with each sample sheet.

PRESERVATION OF DOCUMENTS

Note : A rate of 120 revolutions per minute in glycerine operated machine is usually satisfactory.

Report : Report the type of tester used and give the average, maximum and minimum values of the reading for each side separately.

Burst Factor : Used for comparing two papers with regard to their bursting strength.

$$\text{Burst factor} = \frac{\text{Bursting strength in g per sq. cm}}{\text{Substance in g per sq. m}}$$

Folding Endurance

General : A folding endurance test is the best available criterion of the serviceability of paper that is creased or folded repeatedly. This test gives information about certain properties of paper, such as durability, which cannot be obtained by other tests.

Equipment : 'Schopper' type Double Fold Testing Machine is recommended. The machine is driven by motor or countershaft, with the help of friction pulley at such a speed that 90 to 120 double folds per minute are effected. When the machine runs, the slotted folding blade slides back and forth in reciprocating motion between creasing rollers. The clamps are under spring tension, which can be varied. The number of times the paper goes through each double fold (back and forth) is counted on a rotating disc known as counter which is designed to count up to 10000 double folds.

Test Pieces : These are cut from machine and cross directions exactly 15mm wide and 97 mm long. At least one test piece in each direction shall be cut from each sample specimen.

PRESERVATION OF DOCUMENTS

Precautions : Before putting test pieces on the machine, see that the machine is in locked position, bring the counter to ZERO position, fasten the paper securely in clamps and see that it is free from creases and folds.

Procedure : Slip the test piece into the slotted folding blade and hold it in clamps placed 90mm apart. Adjust the spring tension so that it is not less than 770g when the clamps are farthest apart and not more than 1050 g when they are nearest together. Start the machine and keep the test piece folding back and forth until breakage occurs. Perform the test on all the test pieces.

Report : Report the average, maximum and minimum of the number of double folds, that the best pieces can sustain up to rupturing point in each direction separately.

CHEMICAL PARAMETERS

Determination of $p^H(a)$

SURFACE p^H : Apparatus : The following apparatus is required.

p^H meter : Any standard pH meter with glass electrode and a single combination electrode calibrated against standard buffer solutions at two pH values 4 & 9.

Reagents : The following reagents are required

Buffer Solutions : Two standard solutions, one which p^H 4 and the other with p^H 9.

Distilled water : pH 6.0 to 7.2 and carbon dioxide free water.

Procedure : Cut a test specimen approximately 50 x 50 mm from the sample sheets. Place one large drop of distilled water on the test piece and place electrode in drop, also touching the paper. Take the reading on pH meter after about two minutes.

PRESERVATION OF DOCUMENTS

p^H VALUE (b)

General : The following method is suitable for the regular run of commercial and industrial papers the water extracts of which are normally acidic and usually buffered. It is not adequate for determining the p^H of unbuffered and neutral papers, such as insulating papers, which require a more accurate method to eliminate error due to the absorption of carbon dioxide by the water extract during its preparation and testing.

Apparatus : The following apparatus is required.

Electrometric pH meter : Any standard pH meter, Calibrate against standard buffer solutions at two pH values.

Glass-ware : As required under neutral and resistant to acids and alkalies.

Reagents : The following reagents are required

Buffer Solutions : Two standard solutions, one with p^H4 and the other with p^H9.

Distilled water of p^H 6.5 to 7.2

Procedure : Cut or shred about 1 g of the specimen in a 125 ml. Erlenmeyer flask fitted with a ground-glass air condenser and add up to 20 ml of boiling distilled water in small portions till the paper is wetted. Add another 50 ml of distilled water, fit the reflux air condenser and digest, with occasional shaking, at 98° to 100°C for one hour. At the end of the digestion, cool to 45° to 40°C, with the air condenser in position and its top covered by a small beaker. Remove the air condenser, shake the flask thoroughly, close it tightly with a clean rubber stopper, set aside in a cold water bath and cool to room temperature. Determine the p^H of the supernatant

PRESERVATION OF DOCUMENTS

liquid with the pH meter. Make at least two determinations on test pieces from two separate specimens and if the value differs by more than 0.4 repeat with two fresh specimens. Reject the highest and lowest and report the average.

Excessive contact with air shall be avoided.

COPPER NUMBER

The copper number of paper is defined as the number of grams of metallic copper in the cuprous oxide resulting from the reduction of copper sulphate, under the conditions of this method by 100g of the paper.

The copper number may be regarded as an index of those impurities in cellulose, such as oxycellulose, hydrocellulose, lignin etc., which possess reducing properties. It is valuable for detecting changes accompanying deterioration and may, therefore, be considered as a test for indicating the permanence of paper.

Apparatus

The apparatus shall consist of the following.

Grinder — A grinder that will completely disintegrate the paper without heating or contaminating it. The grinder shall be a Koerner type or its equivalent.

Bath — a steam or oil bath maintained at $100^{\circ} \pm 1^{\circ}\text{C}$.

Reagents

Copper Sulphate Solution-Dissolve 100g of copper sulphate crystals ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in water and dilute to one litre.
Carbonate-Bicarbonate Solution dissolve 350g of sodium carbonate powder ($\text{Na}_2\text{CO}_3 \cdot \text{OH}_2$) or 129g of anhydrous sodium carbonate (Na_2CO_3) and 50g of Sodium bicarbonate (NaHCO_3)

PRESERVATION OF DOCUMENTS

in water and dilute to one litre.

Molybdophosphoric Acid — Dissolve 100g of sodium molybdate crystals ($\text{NaMo}_4 \cdot 2\text{H}_2\text{O}$) and 75 ml of phosphoric acid (83 percent) in a mixture of 275 ml of sulphuric acid (sp gr 1.84) and 1.75 litres of water.

Sodium Carbonate Solution — Approximately 5 percent (w/V) in water.

Standard Potassium Permanganate Solution : (0.05N) Dissolve 1.581 g of Potassium permanaganate in water and dilute to one litre in a volumetric flask. Standardize against Sodium oxalate as the primary standard.

Procedure

Completely disintegrate the test pieces in the grinder. Allow the ground material to come to moisture equilibrium with the atmosphere of the balance and weigh a portion of 1.5 g to the nearest 0.10 g.

Immediately before use, add 5.0 ml of copper sulphate solution to 95ml of carbonate-bicarbonate solution. Bring the mixture to boil in 2 min and pour it over 1.5 g of the ground sample in a 125-ml Erlenmeyer flask. Stir well with a glass rod in order to distribute the fibres and to remove air bubbles. Fit the flask with a loosely fitting glass bulb or stopper and submerge completely in steam-bath at atmospheric pressure. Occasionally filtrates tend to float to the surface, therefore, the flask should be shaken from time to time to redistribute them. Remove the flask from the steam-bath at the end of 3 hours. Filter through an ashless filter paper in a 7.5 cm Buchner funnel using section. Wash by flooding with 100ml Sodium carbonate solution at about 20°C and then by flooding with 250 ml of hot water at about 95°C, discarding the filtrates.

PRESERVATION OF DOCUMENTS

Transfer the fibres and filter paper to a small beaker, add 25ml of the molybdophosphoric acid solution, and macerate well with a flattened glass rod. Transfer to a Buchner funnel and wash thoroughly with cold water until the blue molybdenum colour is removed from the fibres.

Dilute the filtrate with water to approximately 70ml and titrate with 0.05 N Potassium permanganate solution to a faint pink colour.

Calculation :

Calculate the copper number as follows

$$\text{Copper number} = \frac{6.36 \text{ V N}}{W}$$

Where

V = volume in ml of Potassium permanganate solution required for the titration.

N = normality of Potassium permanganate solution, and

W = weight in g of the sample taken

Reporting :

The copper number shall be reported on the basis of total fibre content. Not less than two determinations shall be made and the average of the results, rounded off to the nearest 0.1, shall be reported.

Reproducibility :

Duplicate determinations should agree within 0.2.

PRESERVATION OF DOCUMENTS

ASH CONTAIN

General : Though all fibrous materials that are used for the manufacture of paper and allied products have an inherent ash is generally small. The percentage of ash is, therefore, taken to be an index of added mineral matter or loading.

Procedure : Tear about 1g of the specimen into small shareds and place in a previously weighed crucible and again weighed. Heat carefully over a Bunsen burner to ensure that the paper burns quietly until it is entirely charred. Transfer the crudible into a muffle furnace at $800^{\circ} \pm 25^{\circ}\text{C}$ and heat until all the carbonaceous matter is burnt off. Cool the crucible in a desicator, weigh and repeat the operation till the weight is constant.

Calculation

Calculate the ash percentage on the original weight of the material is as follows

$$\text{Ash percent by weight} = 100 \frac{W - X}{W}$$

Where

w = weight in g of the crucible with the ash

X = weight in g of the crucible, and

W = weight in g of the crucible with the material

Report : Make the determination of three specimens and report the average, maximum and minimum of the results.

SIZING

Qualitative Tests : Various sizing materials are used, among which starch, resin and gelatin are important. The following

PRESERVATION OF DOCUMENTS

methods of test are prescribed for identifying these sizing components.

Starch Sizing : Drop on a test piece with a glass rod, a weak solution of iodine in Potassium iodide approximately 0.005 N. Alternatively treat a hot water extract of the paper with the iodine solution. The appearance of a distinct blue colour indicates the presence of starch, the deeper the colour, the greater the quantity of starch.

Note : A faint colour must not be taken as evidence of a added starch, as in rag pulp, it is very difficult to remove starch from the raw materials.

Rosin Sizing

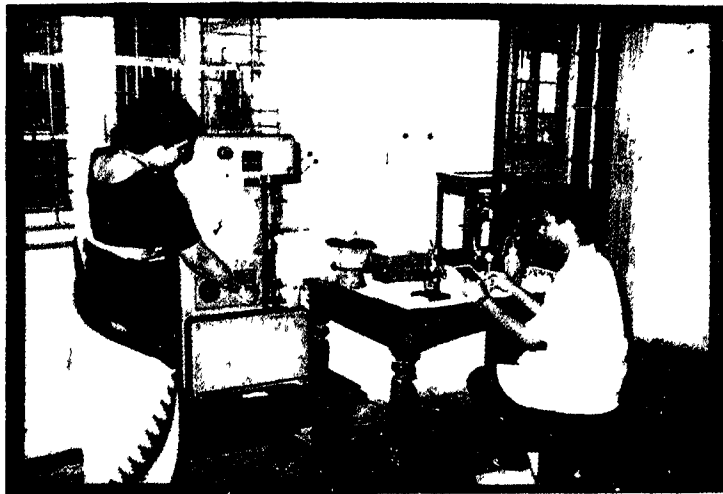
- a) Take a test piece of paper, about 200 x 25mm (or 8 x 1 in.) pleat it repeatedly, place it in a test tube and cover it with rectified spirit (conforming to IS : 323-1952). Place the test tube in a beaker containing water and heat slowly to dissolve the rosin. Cool the solution and pour it into a test tube half full of distilled water. If rosin is present it will appear as a ring, whitish in colour, at the junction of the two liquids. When the test tube is shaken, the liquid will have opalescent appearance.
- b) **Ring Test :** Allow a drop of ether to evaporate on the surface of a test piece and a ring will be formed. This test gives by all ether-soluble materials.

Gelatine Sizing

Cut up a small quantity of paper from the specimen and boil for a few minutes in a beaker containing sufficient water to cover the paper. Pour off into a test tube, cool, add a few drops of 2 percent solution of tannic acid. A flocculent

PRESERVATION OF DOCUMENTS

precipitate indicates that the paper has been sized with gelatine. On heating the liquid, the precipitate will coagulate and cling to the sides of the test tube.



Paper Testing Machine

PRESERVATION OF DOCUMENTS

Appendix — VI

PRESERVATION MATERIALS AND CHEMICALS

1. Marble chips
2. Calcium Oxide
3. Calcium Carbonate
4. Hydrochloric Acid
5. Sulphuric Acid
6. Methanole
7. Barium Hydroxide
8. Ammonia
9. Thymol
10. P. Nitrophenol
11. Penta-chlorophenol
12. Arsenic Oxide
13. Zinc Phosphate
14. Zinc Chloride
15. Formalin
16. Lead Carbonate
17. Acetone
18. Benzene
19. Cedar-Wood Oil
20. Bees - Wax
21. Lanolin anhydrous
22. Starch
23. Clove Oil
24. Saffrol
25. Glycerine

PRESERVATION OF DOCUMENTS

26. Dextrin Powder
27. Cresote
28. Sodium benzoate
29. Ethylene dichloride
30. Carbon tetrachloride
31. Para-dichlorobenzene
32. Pyrethrum (pip)
33. Trypsin
34. Protease
35. Marble Paper

EQUIPMENT AND MACHINE OF PRESERVATION LABORATORY

1. Repairing glass top table
2. Hand press size (18" x 24")
3. Desk trimmer (16" x 18")
4. Gilotine trimmer (24")
5. Scissors (big 9")
6. Scissors (small 6")
7. Knives for paper cutting sharp, 6" blade.
8. Pairing knives or rampi or nich Karda
9. Cups and dishes-brass or porcelin and soft brushes 2"
10. Straight edge-steel 12"
11. Swing needles (big and small)
12. Bod kin
13. Enamel Trays
14. Brushes (Camel hair, 2.5 to 3.0 cm wide)
15. Dagchi for preparing paste
16. Electric iron
17. Lying Press
18. Nipping Press

PRESERVATION OF DOCUMENTS

19. Heater or stove
20. Air tight Fumigation chamber
21. Vacuum Fumigation chamber
22. Fog producing machine for spray of insecticides
23. Thymol air-tight Fumigation chamber (Wooden)
24. Laminator machine
25. Cutting machine
26. Board shearing machine
27. Vacuum cleaning machine (Douvac or Mano Vac.)
28. Fumax (Spray machine)
29. Hand Sprayers (Ganesh)
30. Electronic balance
31. Storage Cabinets
32. Large flat smooth tables
33. Paper testing
 - i) folding
 - ii) Shearing
 - iii) Bursting
 - iv) Stensile strength
34. Kipp's apparatus
35. Enamel Tray, (20" x 30")
36. Dehumidifyer
37. p^H meter
38. Encapsulation Machine
39. Viscometer
40. Muffle Furnace

Appendix — VII

Availability of Preservative materials, equipments and machines

The National Library of India received frequent requests from Library and Manuscripts repositories for information concerning the sources of availability of the equipments and materials required for conservation of records and manustripts. Some names of the manufacturer/agents dealing with rare materials are listed below. The list is not exhaustive one and does not necessarily convey any recommendation on behalf of National Library of India for the firms listed.

Materials

- a) Tissue paper (white superior, acid free, 20" x 30", 9-10 gram sq. meter)
 - 1. M/s. Handmade paper Research Centre, Poona.
 - 2. M/s. Eastern paper mart, Chatra Chahjs, Chawri Bazar, Delhi - 6.
 - 3. M/s. Gulshan Rai Jain & Sons, Post Office Street, Sardar Bazar, Delhi - 6.
 - 4. M/s. Hara Lalka, 5 Lenin Sarani, Calcutta - 13.
 - 5. M/s. Jai Dayal Kapoor & Sons Pvt. Ltd., P..B.N. 1204 Chawri Bazar, Delhi - 6.

Less Tissue paper imported

- b)
 - 1. M/s. Tokiwa Sangyo KK, 986 Muroshin Machi, Takamatsu, Chi Kagwa Prof. Japan, Telex -5822250.
 - 2. M/s. Kasuga Seishi Kogyo KK, 760-1, Hina, Fuji Shi, Shizuoka, Japan, Telex - 3925356 Kasugaj.

PRESERVATION OF DOCUMENTS

3. M/s. Kiki Tikusher Paper Mrg, Co. Ltd., 719-13, Tenna, Fuji Shiznoka 419-02 Fuji, Japan, Telex-3925-415.
4. M/s. Tentok Paper Co. Ltd., 719-13, Tenna, Fuji Shiznoka 419-02 Fuji, Japan, Telex-3925-415.
5. M/s. Sonyo Scott Co. Ltd., 14-2 Nagta-cho 2-chome, Chiyoda-Ku Tokyo, Japan.
6. M/s. James R. Crompton & Bros Ltd. Eltron Paper Mills. Burry Lancashire, England.
7. M/s. Spicers. 19, New Bridge Street, London EC 4, England.
8. M/s. Andrews/Nelson/Whitehead, 31-1048 H Avenue Long Island City, New York 11101, 212/937-7100 U.S.A.
9. M/s. B. W. Wilson paper Co., Richmond Virginia, U.S.A.
10. M/s. Mudge Paper, Co., 501, Water Street, Baltimore.
11. M/s. Barton Buer & Paper Co., 111, 2nd Street, S.E. Washington DC.
12. M/s. R. P. Andrews Paper Co, 1st & H Street, S.E. Washington D.C.
13. M/s. W.J. Alcock & Co. Pvt., 7, K. S. Roy Road, Calcutta 700 001 (Importer).
14. M/s. R. S. Enterprise 115, India Biswas Road, Calcutta - 37.
15. M/s. Barcham Green & Co. Ltd., Hayle Mill Maidstone, Kent ME 15, 610 London.
16. M/s. Green Chamical, 1418, Nicholson Road. Kashmir Gate, Delhi - 110 006.

PRESERVATION OF DOCUMENTS

c) **Oiled paper and Waxed paper**

1. M/s. Bhor Industries Ltd., Bhor Villa, Poona.
(Regd. Office Sir Vithal Das Chambers, 16, Bombay Samachar Marg, Bombay - 1)
2. M/s. Kishore Brothers, P-23-24, Radha Bazar Street, Calcutta - 1.
3. M/s. Gulshan Rai Jain & Cons, Post Office Street, Sadar Bazar, Delhi - 6.
4. M/s. Dharampur Leather Cloth Co. Ltd., 10 Chowpatty, Bombay - 7.
5. M/s. paper Products Ltd., Vaswani Mansion, 5th floor, 120, Dinsha Vacha Road, Bombay - 1.
6. M/s. Diamond Products, 4, Clive Row, Calcutta - 1.
7. M/s. Indian Waxing Co., 12, Baven Tala Street, Calcutta - 7.

d) **Hand Made Paper.**

1. M/s. Handmade paper Ltd., Ogulevadi, P.O. North Street, District Maharashtra.
2. M/s. Khadi & Village Industries Commission, P.O.B. No. 482, Bombay.
3. M/s. Handmade Paper Research Production Centre, Kalyani, W. Bengal.
4. M/s. Handmade paper Research Centre, Poona.
5. M/s. C.S.I.R. Regional Research Laboratory, P.O. Regional Research Laboratory, Hyderabad Deccan.
6. M/s. Shri Aurobinda Ashram, pandicherry.
7. M/s. Kasturba Seva Mandir, Rajpura (Punjab).
8. M/s. Manoj Harbalka, 5, Lenin Sarani, Calcutta - 13.

PRESERVATION OF DOCUMENTS

e) **Straw Boards and Hard Pressed Mill Boards**

1. M/s. paper & Pulp. Conversion Ltd. Khopoli, Kolba, Bombay.
2. M/s. Union Paper & Board Mill Ltd., 183, Netaji Subhash Road, Calcutta - 1.
3. M/s. Straw Board Manufacturing Co. Ltd., Sharnpur, (U.P.)
4. Chandigarh Paper Board Mills Pvt. Ltd., 26, Industrial Area, Chandigarh, Punjab.
5. M/s. Straw Products Ltd., 2, Mangoe Lane, Calcutta - 700 001.
6. M/s. Western India Paper & Board Mills Pvt. Ltd., P.B.N. 727, Bombay - 1.

f) **Synthetic Fabrics**

1. M/s. Calico Chemical & Plastic Division, 44, Rani Jhansi Road, New Delhi - 55. *
2. M/s. S. D. Mehrotra & Sons, 21, Bank Colony, Gash Road, Meerut (U.P.).
3. M/s. Union Carbide India Ltd. (Chemical & Machine Division) 15-Mathew Road, Bombay.

g) **Cellulose Acetate Foil (0.00088 inch)**

1. M/s. British Calaness Overseas Ltd. Calaness House, Hanover square, London, W. 1. England.
2. Calaness Corporation of America Plastic Division, 290, Ferry Street, New York 5 NY U.S.A.
3. M/s. Industrial and Allied Chemical, Bombay.
4. M/s. Garware Plastics pvt. Ltd., Vila Parle Western Express, Highway Bombay - 57.
5. M/s. La Cellophans, 110, Boulevard Hansmann, Paris, France.

PRESERVATION OF DOCUMENTS

6. M/s. Volts Ltd., Chemical Division. 7/1, Asaf Ali Road, New Delhi - 110 002.
7. M/s. Lonze Works Ele Ktro Chemical Fabriken, G. M. B. Hi, 17-B, Weilam Rhein, Baders, Deutchand.

h) **Fire Fighting equipments**

1. M/s. Miniax Ltd., Merchantile Building, Lall Bazar, Calcutta - 1.
2. M/s. Kooverji Devashi & Co., Pvt. Ltd., 10, Anen Chambers, Tardeo Road, Bombay - 400 043.
3. M/s. Merry Weather Fire Equipment, 805 Prasad Chambers, Opera House, Bombay - 400 004.
4. M/s. Zenith Fire Service, 127-129, Mody St. Bombay - 400 001.
5. M/s. D. G. I. Pvt. Ltd., 14M, Block Cannaught Circus, New Delhi - 1.

i) **Appliances and Equipment**

Vacuum cleaner and Electric Iron

1. M/s. Associate Electrical Industries India Ltd., Nichal Road, Bombay.
2. M/s. Rallis India Ltd., 10/90B-Connaught Circus, New Delhi - 1.
3. M/s. Hindustan General Electrical Co. Ltd. 5, Royal Exchange Ltd. Calcutta.
4. M/s. India Electric Works Ltd., Diamond Harbour Road, Calcutta - 700 038.
5. Eureka Forbesh Ltd., 42, Taratala Road, Calcutta - 700 034.
6. M/s. Green's Chemicals, 1418, Nicholson Road, Kashmeri Gate, Delhi - 110 006.
7. M/s. Test Inspection & Service, 20, Netaji Subhas Road, Calcutta - 700 001.

PRESERVATION OF DOCUMENTS

j) **Sewing Fog Machine**

Manufactured by

1. M/s. Jardine Henderson Ltd., 4, Clive Row, Calcutta - 700 001.

k) **Sprayers**

1. M/s. Amar Nath Kandelwal, 24/157, Shakti Nagar, Subzi Mandi, Delhi - 6.
2. M/s. Shaw Wallace & Co. Ltd. 8/9, Thambe Chatty Street, Madras - 1.
3. M/s. American Spraying and Pressing Works, Karva Road, Malad, Bombay - 64.
4. M/s. Mrityunjoy Store, 127, Biplabi Rashbehari Basu Road, Calcutta - 700 001.
5. M/s. Agro Suppliers Syndicate, 16, Ganesh Chandra Avenue, Calcutta - 700 001.

l) **Impex Lamination Machine**

M/s. Astra Machino Impex Varsavska, 9, Zagrab, Yugoslavia and other agent in India, M/s. Yogo-Intrac Co. Pvt. Ltd. D-36, Flat No. 8, South Extn. part II, New Delhi - 110049.

m) **Vacuum Fumigation Chamber**

1. M/s. W. J. Alcock Pvt. Ltd., 7, K. S. Roy Road, Calcutta - 700 001
2. M/s. F. F. Stokes Machine Co., 5910, Tabor Road, Philadelphia 20, Pa, U.S.A.
3. M/s. Scientific Engineering Company, 1, Sambhunath Pandit Street, Calcutta - 700 020

n) **Dehumidifier**

1. M/s. C. Doctor & Co., 11, Bruce Street, Bombay - 1
2. M/s. Dry Fact, 20, Rajpur Road, Delhi - 110 054

o) **Record paper cutting Machine**

1. M/s. India Engineering Works, 13/1, Bondel Road, Calcutta - 700 019.

PRESERVATION OF DOCUMENTS

p) **Temperature & Humidity : Thermo grapher**

1. M/s. Bestobell India Pvt., Ltd., 21, Camac Street, Calcutta - 700 005.
2. M/s. Sehgal Sons, A-14/3, Asaf Ali Road, New Delhi - 110 002.

q) **Relative Humidity Hair Hydrometer**

1. M/s. Sehgal Sons, A-14/3, Asaf Ali Road, New Delhi - 110 002.
2. Starch & Allied Products, Electronic Division, 308, Khareb Bazar, Bombay - 9.
3. M/s. Dry Fact, 20, Rajpur Road, Delhi - 110 054.

r) **Pip and other insecticides and fungicides**

1. M/s. Mrityunjoy Store (Sole agent of pip) 127, Biplabi Rash Behari Bose Avenue, Calcutta - 700 001.
2. M/s. Bombay Chemical, 129, Mahatma Gandhi Road, Bombay - 23.

s) **Para-dichlorobenzene**

1. M/s. Laxmi Chemical Industries, "Neel Kamal" Flat No. 45, 4th floor, Podder Road, Bombay-400 026
2. M/s. Mrityunjoy Stores, 127, Biplabi Rash Behari Basu Road, Calcutta - 700 001.
3. M/s. Goodwill Chemical Industries, 495/97, Kalbadevi Road, Bombay - 400 002.
4. M/s. Durgapur Chemicals Limited, 6, Little Russell Street, Calcutta - 700 001.

t) **Fumigant : Ethylene dioxide and carbondioxide (1:9)**

1. M/s. Pest Control (India), 23, Mirza Ghalib Street, Calcutta - 700 016.
2. M/s. Bengal Pesticide (P) Ltd., 10, Clive Row, Calcutta - 700 001.

PRESERVATION OF DOCUMENTS

3. M/s. Pest Control & Co., 9A, Ram Mohan Dutta Road, Calcutta - 700 020.

u) **Sodium Salt of Carboxy methyl cellulose**

1. M/s. Wassan Bros. 26, Jawaharlal Nehru Road, Calcutta - 700 013.
2. M/s. Chempur (P) Ltd., 13/4, Lower Chitpur Road, Calcutta - 700 001.
3. M/s. D. Jayanti Lal & Co. 33, Biplabi Rash Behari Basu Road, Calcutta - 700 001.
4. M/s. Lab. Equipment & Chemical, 11, Pollack Street, Calcutta - 700 001.

v) **Cellulose acetate film (.01mm)**

1. M/s. E. I. Dupont De Nemours & Co. Willmington 93, Delwere U.S.A.
2. M/s. British Calanese Overseas Ltd., Calanese House Square, London, W.I. England.
3. Calanese Corporation of America, Plastic Div. 290, Ferry Street, I New York, 5NY, U.S.A.
4. M/s. Amul Company, Inc, 180 Madison Avenue, New York, 16NY. U.S.A. (Agent in India M/s. Industrial and Allied Chemical, Bombay).
5. M/s. La Cellophans, 110, Bontevard, Hanaman, Paris 80, France. (Local agents M/s. Volts Ltd., Chemical Divn. 7/1, Asaf Ali Road, New Delhi.

w) **Polyester Welder (encapsulation)**

1. M/s. Green's Chemicals, 1418, Nicholson Road, Delhi - 110 006.
2. M/s. W. J. Alcock Pvt. Ltd., 7, K. S. Roy Road, Calcutta - 700 001.

PRESERVATION OF DOCUMENTS

3. Curataur Polyester Sealers, Ensington, Maryland-20895-248 U.S.A.

x) **Handmade paper**

1. M/s. Macrom Marketing, 5, Lenin Sarani, Calcutta - 700 013.
2. M/s. National Physical laboratory, Hillside Road, New Dehi - 110 012.
3. M/s. Handmade paper Research Centre, Agricultural College Compound, Poona - 5.
4. Handmade paper Research Production Centre, Kahjani, West Bengal.
5. M/s. C.S.I.R. Regional Research Laboratory, P.O. Regional Research Laboratory, Hyderabad.
6. M/s. Kerala Paper Industries, Puthan Chantal, Trivandrum, Kerala.
7. Handmade Paper Research Centre, Kalyani, P.O. Majherlay Nadia.
8. Handmade paper Ltd., Ogalewali Dutta Salana, Bombay.
9. Rishi Arbinda Ashram, Pondichary.

y) **Fumigation Chamber**

1. M/s. Steelax Furniture, 306, B. B. Ganguli Street, Calcutta - 700 012.
2. M/s. Broolux & Co. Pvt. Ltd., 77/1, B. Manscatale, Calcutta - 700 023.
3. M/s. W. J. Alcock & Pvt. Ltd., 7, K. S. Roy Road, Calcutta - 700 001.

z) **Binding Material : Straw Board**

1. M/s. Paper and Pulp Conversion Ltd., Khopoli, Lolabu, Bombay.

PRESERVATION OF DOCUMENTS

2. M/s. Union Paper & Board Mill Ltd., 183, Netaji Subhas Road, Calcutta - 700 001.
3. M/s. Straw Products Ltd., 2, Mangoe Lane, Calcutta - 700 001.

z₁) Paper and Book Binding Materials

1. M/s. G. P. Enterprise, 2/B, Candi Bose Lane, Calcutta - 700 065.
2. M/s. Print and paper (Sales) Pvt. Ltd., Chawari bazar, Delhi.
3. M/s. Agfa Gevert India Ltd., 2A, Shakespeare Sarani, Calcutta - 700 071.

z₂) Teflone Cloth

1. M/s. Vidyut Udyog, 5, Fancy Lane (4th floor), Calcutta - 700 001.
2. M/s. G. D. I. Engineering Co. Pvt. Ltd. 135A, B. R. B. Basu Road, Calcutta - 700 001.
3. M/s. Hind Chem Co. 178, Rash Behari Avenue, Calcutta - 700 029.
4. M/s. Scientific Instrument & Chemical Co., 24, Camac Street, Calcutta - 700 016.

Availability of pheromone & Fuji Trap

The "New Service" is manufactured by Fuji Flavor Co. Ltd. of Tokyo, Japan and distributed world wide by Tama Trading Co. Ltd. of Tokyo, Japan. The U.S. distributor, Insects Limited, Inc 10540. Jessup Boulevard, Indianapolis, Indiana, U.S.A. 46280. They are shipped ten packages or twenty packages (200 traps) per carton.

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PRESERVATION OF DOCUMENTS

Appendix — IX

NATIONAL LIBRARY, CALCUTTA
STAFF PATTERN OF CONSERVATION DIVISION

PRESERVATION DIVISION
Asstt. Library and Information Officer

Binding Unit	Preparatory Unit
Library & Information Asstt.	(Professional Staff)
LIA (Foreman)	Library & Information Asstt
Library Clerk (Binder & Mender)	Library Clerk
Library Attendant and Labourer	Senior Library Attendant
	Library Attendant

LABORATORY DIVISION
Asstt. Library & Inf. Officer
(Chemist)

Library and Information Assistant (Asstt. Chemist)	Library & Information Asstt. (Machine Operator)
Library & Information Asstt./	Library Clerk (Mender)
Sr. Laboratory Asstt.	Library Attendant and Labourer
Library & Information Asstt	
Library Clerk	
(Laboratory Assistant)	
Sr. Library Attendant	
(Laboratory Attendant)	

REPROGRAPHY DIVISION

Asstt. Library & Inf. Officer (Reprography)	Asstt. Library & Inf. Officer (Microphotographer)
Library & Inf. Assistant (Technical Asstt)	Library & Inf. Assistant (Asstt. Microphotographer)
Library & Inf. Asstt. (Machine Operator)	Library Clerk (Photo Asstt.)
Sr. Assistant	Sr. Library Attendant (Laboratory Attendant)
Library Attendant and Labourer	Library Attendant (Dusting Bearer)

PRESERVATION OF DOCUMENTS

I N D E X

Acetic Acid	78
Adhesives	73
Air-conditioning	107
Aldrin	187
Alkalinity	44
Animal Glues.....	136
Antiquities	42
Aromatic Acids	78
Aspergillus flavus	178
Aspergillus fumigates	178
Aspergillus nidulans	178
Aspergillus niger	178
Aspergillus sulphureus	178
Auto-catalytic	216
Azadirachta	109
Babylonia	7
Backing	129
Back Paper.....	129
Barium Hydroxide	47
Beater	15
Benzoic acid	78
Bhurjapatra	8
Biodeterioration	151
Bleaching	78
B-Napthol.....	189
Board cutting	129
Bower & Godfrey Collection	9

PRESERVATION OF DOCUMENTS

Carbonate	46
Carboxyl group.....	41
Carboxy Methyl Cellulose.....	62
Carboxymethyl Steroid	109
Catastrophic	216
Cellulose Acetate	216
Chemical Emulsion	186
Christopher Phipps.....	19
Chlordane.....	187
Chlorine	78
Citronella Oil.....	72
Cockroach	159
Coleoptera Beetle	155
C.M.C.	58
Commercial Alum	27
Co-ordination Theory.....	31
Crystallization	81
Cunninghamm	7
Curative	1
 Danpatra	 8
Dandy roll	16
Dashakumara	7
Dehumidifiers	90
Dharmavedhi	10
Disaster plan	87
Drachslera tetramera	178
 Ecological	 151
Egyptians	4
Engine sized.....	15

PRESERVATION OF DOCUMENTS

Engraved	6
Epoxy Resin	140
Essential Oil	72
Eutectic point	82
Ferted	22
Formalin	183
Formic acid	78
Fourdrinier	18
Freezing process	81
Fumigation chamber	164
Fusarium exysporum	178
Gelatin	214
Glycerine	69
Gum	74
Gutenberg	21
Half Stuff	15
Halogenation	77
Heptachlor	187
Hickys	76
Hydrocarbons	77
Hygrometer	90
Homogeneity	144
Hrozny	9
Jacket	206
Jatakas	7
John Boskerville	16

PRESERVATION OF DOCUMENTS

Kharosthi Script	9
Kumarsambhaba	9
Lalitavistara	7
Langwell	46
Lasioderma Serricorne	157
Lignin	41
Macro-biodeterioration	151
Magnesium Methoxide.....	50
Margosa.....	109
Mechanical Wood Pulp	76
Mechanical Ventilation	150
Mesopotamia	7
Methyl Cellulose.....	79
Micholson	23
Micro-environment	119
Microfiche	208
Micro-opaque.....	206
Morpholine	47
Moxon	22
Mucilages	77
Mulberry	11
Natural dyes	77
Nepalese handmade paper	63
Newsprint	28
Nicgrospora	178
Nicholas Louis.....	15
Nitrogen oxide	219
Non acidic.....	222

PRESERVATION OF DOCUMENTS

Non-corrosive	222
Organic acid.....	77
Oxidation	41
Oxycellulose	41
Ozone	218
Papillon	23
Papyrus	4
Paranitraphenol	183
Parchment	4
Pencillium	182
Pentachlorophenol.....	183
Perishable	6
Peroxide	215
Phalakas	7
Phenolic Hydroxyl group	78
Photo oxidative	216
Plastic cans	224
Plasticizers	134
Plastic spools	224
Polyacriyl acetate	74
Polyester	115
Polymethyl methacrylate	139
Polyester Polypropelene	71
Polysaccharide.....	34
Polyvinylacetate	62
Polyvinyl alcohol	139
Polyvinyl chloride	224
Potassium bromide	227

PRESERVATION OF DOCUMENTS

Preventive	2
Protease	74
Protein.....	74
Reader Printer	208
Rehabilitation	98
Resins	77
Rosin size	28
Restoration	100
Rounding	130
Royal eulogy.....	6
Relative humidity	143
Semi Chemical Pulp.....	76
Sermons in stone	6
Sets.....	30
Sewing.....	126
Silicagel.....	113
Silver mirroring	216
Silver oxidation	217
Silver sulphide	227
Silver thiosulfate	217
Sludge	28
Smith	36
Starch.....	73
Stegobium Paniceum.....	156
Sterilization	180
Stylus	4
Sulfonation	77
Sulphur dioxide	112

PRESERVATION OF DOCUMENTS

Tala Patra	9
Tamrapatra	8
Tamrasasana	8
Tannin	77
Teflon	59
Thaneroclerus Bugueti Larvae	158
Thermodynamics	1
Thermosetting	140
Thiolignin	78
Trimming	128
Tripitakes	9
Trypsin	74
Ultraviolet	35
Ultraviolet radiation	112
Vacuum Fumigation Chamber	165
Vasavadatta	10
Vellum	5
Vinayapitaka	7
Viscosity	80
Volatile oil	77
Zinc phosphate	174

PRESERVATION OF DOCUMENTS

**“CONSERVATION IS
EVERYBODY'S RESPONSIBILITY”**

**“CLEANLINESS IS THE
ETHICS OF CONSERVATION”**

AUTHOR'S BIOGRAPHY



The author was born in 1940 in the district of Khulna (now in Bangladesh) and started his career as an Assistant Teacher at Bagha Jatin High School, Calcutta where he was a student. Then he served for twelve years at the Central Inland Fisheries Research Institute (ICAR), Barrackpore, West Bengal where he presented a seminar paper as Co-author which has been published in the journal of Inland Fisheries Society. He joined in the National Library, Calcutta under the Dept. of Culture, Ministry of Human Resource Development as a Chemist through Union Public Service Commission in the year 1980. The author imparted Preservation Training to the staff members of different Govt. Organisations and act as an advisor to the large libraries for conservation aspects. In the year 1991, the Dept. of Culture offered him an opportunity to present a paper to the Conference of International Federation of Library Association (IFLA) held in New York, U.S.A. He also presented three papers at different times on Restoration of Library Resources at the Conservation Seminars which were published in the Journal Indian Association for the Study of Conservation. The author was promoted to the post of Deputy Librarian (now redesignated as Library & Information Officer), Science & Technology Division in the year 1991 and served as Head of Conservation.